MODERN METHODS OF DIAGNOSIS

IN

URINARY SURGERY

DEANESLY

MODERN METHODS OF DIAGNOSIS

IN

URINARY SURGERY

BY

EDWARD DEANESLY, M.D., B.Sc. LOND., F.R.C.S.

Hon. Surgeon Wolverhampton and Staffordshire General Hospital

LONDON

H. K. LEWIS, 136 GOWER STREET, W.C.

1907

PREFACE.

SPECIALISM is no new thing in surgery, for it existed among the ancient Egyptians to a degree even more extreme than at the present day. It has its origin indeed in the nature of surgery itself, for the keynote of surgery is the local treatment of local diseases. Nevertheless the body, in spite of the number and diversities of its parts, is a unit. Its local mechanisms are all composed of the same fundamental elements and are all controlled and harmonized by means of the circulatory and nervous systems. The art of surgery has the same fundamental unity to whatever part of the body it may be applied. Specialization in surgery is merely the application to particular parts of the body of the same fundamental principles and methods which it employs in all. It is one of the drawbacks of a too exclusive specialism that it tends to hide this obvious truth. An even greater hindrance to the advance of special branches of surgery has been the powerful influence of historic tradition perpetuated by the textbooks and teaching which are provided for medical students in the ordinary schools.

Even the most recent textbooks of general surgery rarely reflect the best practice of the day among good surgeons. Often their teaching is ludicrously inadequate, and any student who gives modern replies to ancient questions runs the risk of being rejected by his examiners.

There is no branch of surgery which has been more hampered by tradition than that of the genito-urinary organs. The great names of the past associated with this branch of surgery have helped to sanctify their teaching long after it has become obsolete. The operations for stone and stricture devised and practised so skilfully by the accomplished anatomists of the eighteenth and nineteenth centuries still form the gospel of many older surgeons, and their want of cleanliness and ignorance of its necessity is perpetuated in the daily practice of too many practitioners to-day. What mischief arises from this imperfect training is only fully realized by those who have opportunities of seeing its results.

What are the things, then, which distinguish the genito-urinary surgery of the day from that of the past? First, of course, the recognition of the meaning of sepsis and of the methods of preventing it which surgery owes to the immortal work of Lister. Long after Lister had provided the key to this great problem, and after the methods which it indicated had revolutionized abdominal and general surgery, the surgery of the genito-urinary organs continued to be practised on the ancient lines. The minute precautions and care taken with ordinary operations were neglected with operations on the bladder or urethra, and by many surgeons are neglected still. Next to the means of prevention and treatment of sepsis comes the more accurate localization of disease, which we owe partly to the progress of pathology, but more especially to new clinical instruments such as the cystoscope. Since surgery deals only with visible and tangible disease, accurate localization of it by clinical means is essential. Modern

ingenuity has now placed in our hands means of seeing directly or indirectly the whole genito-urinary tract, and of collecting and analysing the secretion of each kidney separately. The cystoscope has been in use for over twenty years and has now reached a degree of simplicity and perfection which render it no more difficult to use effectively than the ophthalmoscope. While the latter, however, is used by every well-trained physician the use of the cystoscope is familiar to few general surgeons in this country, who, nevertheless, continue to practise genito-urinary surgery on ancient lines. General surgeons should not so readily allow the use of this invaluable means of diagnosis to be monopolised by the specialist, and the same remark applies to the newer methods of clinical examination, such as the separation of urinary secretion.

If we except the use of a few instruments devised for facilitating diagnosis and certain operations, there is nothing in genito-urinary surgery which distinguishes it from any other regional surgery. It requires, like all surgery, a sound knowledge of anatomy and pathology, some mechanical aptitude and manipulative skill, rigorous attention to the details of asepsis, and, what was practised by all the great surgeons of the past and is now sometimes neglected, the habit of cutting cleanly and precisely and avoiding unnecessary handling and blunt dissection. Armed with these elementary requirements and with a practical knowledge of a few special instruments, any competent general surgeon may practise genito-urinary surgery by the same methods, and on the same principles as he employs in the rest of his work. But do not let him think that he can achieve satisfactory results, if he

neglects to avail himself of the great improvements which we owe mainly to the ingenuity of specialists.

This little book describes the principal modern methods of localizing and distinguishing those diseases of the urinary organs which are usually assigned to the surgeon, and although it contains nothing which is not already familiar to the urinary specialist, it may perhaps prove useful to general surgeons and others when confronted with problems in urinary diagnosis which the older clinical methods do not solve. As, moreover, it is written by a general surgeon and based on personal clinical experience, it is hoped that other general surgeons may be induced to acquire and practise these methods of precision, which are indispensable for modern work.

CONTENTS.

URINARY SURGERY.

CHAPTER I.

INTERPRETATION OF URINARY SYMPTOMS.

THE first stage in every clinical investigation is to obtain an accurate description of the history and symptoms, so far as they have been observed by the patient or can be elicited by questions. By the term "urinary symptoms" is meant here only symptoms directly and obviously referred to the urinary functions or urinary organs. Symptoms which are in reality due to disease of the urinary organs, but which affect some other parts of the body; for example, the headache of Bright's disease, or the lassitude and wasting of diabetes, are, for the sake of convenience, "not included in the term urinary symptoms." By "interpretation of symptoms" is meant the correct reference of them to their local cause, and the discovery of the nature of the latter. The first step in the process consists in sifting and comparing the symptoms proper—that is, those disordered functions which manifest themselves to the patient. The second step is to ascertain all additional relevant facts by direct examination of the urinary organs and secretions; and the final step is to piece together the facts and frame a diagnosis. A precise diagnosis is only arrived at when a morbid condition of a definite part of the urinary system

sufficient to explain all the symptoms can be demonstrated to sight, or touch, or inferred with practical certainty. In every case the effort should be made to carry the diagnosis to this point. With our accumulated stock of clinical knowledge, and with the accurate means of investigation now at our command, there are few cases of urinary disease which cannot be definitely localized. It should be regarded as a maxim of practice, and not merely a counsel of perfection, that *every gross visible lesion of the urinary tract which can be demonstrated post-mortem is equally capable of being diagnosed during life if proper means are used.*

Urinary symptoms may be conveniently summarized in the following groups:

1. Disorders of micturition.
2. Pain referred to some part of the urinary tract.
3. Abnormal conditions of the urine.
4. Palpable enlargements or malformations of affected organs.

Expressed in another way, we have to answer in every case some or all of the following questions:

1. Is there any disorder of micturition? If so, what is the nature and cause of it?
2. Is there any pain apart from micturition? If so, what is its situation and what the cause of it?
3. Is there any abnormal ingredient in the urine? If so, from what part of the urinary tract is it derived?
4. Do both kidneys secrete normally, equally, and sufficiently?

Normally, micturition is performed without effort or pain from four to six times every twenty-four hours, but is subject to considerable variation in frequency from physiological causes. It varies naturally with the amount of urine secreted, and is therefore generally more frequent in cold than in hot weather. It varies still more according

to the concentration of the urine, the bladder being more tolerant of concentrated than of dilute urine, apart from quantity. It is affected by the amount and nature of food and drink, certain articles of diet being well known to cause an increased flow of urine. Lastly, the desire or power to void urine is affected by habit, and by various emotions and nervous states. "Some there are . . . when the bagpipe sings in the nose cannot contain their urine"; others may be affected by the sight of a urinal, or the sound of a trickling stream. Oftener still, nervousness may deprive a patient for a time of power to void urine.

Omitting these physiological variations, disorders of micturition may be divided symptomatically into two groups of cases: those in which there is increased frequency of micturition without pain, and those in which micturition is painful as well as frequent.

The chief causes of increased frequency without pain are as follows:

1. Abnormal conditions of the urine.
2. Various diseases of the kidney.
3. Displacement of the bladder, or pressure on some part of the lower urinary tract.
4. Early stages of prostatic enlargement.
5. Reflex and nervous causes.

Abnormal conditions of the urine are present in all forms of Bright's disease, and increased frequency of micturition without pain occurs in most of them, especially in the early stages of acute nephritis, when the urine is bloody or highly albuminous; and in the chronic granular form, when the urine is copious and of low specific gravity. In diabetes, in which there is abundant urine of high specific gravity (although without disease of the kidneys), the same symptom is usually present. Nearly all the diseases of the kidney ranked as surgical cause increased frequency;

for example, stone, new growths, tubercular disease, and abnormal mobility of the kidney. Stones in the upper ureter may be classed in this respect with those in the kidney, but it is important to remember that when impacted in the lower ureter, stones give rise not only to frequent but painful micturition.

In the lower urinary tract pressure and displacement are common causes of the same symptom. Such causes are especially common in women in whom pregnancy, displacements, or prolapse of the womb, and all kinds of pelvic tumours can hardly exist without affecting the bladder and the function of micturition. In both sexes hernia is a common and often unsuspected cause of frequent micturition, from more or less involvement of the bladder by the neck of the hernia.

In enlargement of the prostate, before it is complicated by cystitis and sepsis, micturition may be frequent and painless. The capacity of the bladder is reduced by the amount of residual urine which no voluntary effort is able to expel, and the frequency of micturition is in proportion to the amount of effective bladder-space which is lost. It is generally said to be more frequent by night than by day; but this merely means that bladder capacity being reduced to less than is required for a whole night's secretion, the patient is wakened from sleep, while during the day the greater frequency is not noticed. In extreme degrees of prostatic obstruction—the condition of "retention with overflow"—urine may constantly dribble away from a chronically distended bladder, and produce a condition which may be confused with paralytic incontinence if the distension of the bladder is not recognized.

Lastly, there is a group of cases in which the symptom is due entirely to a nervous cause; either a nervous reflex originating in the rectum or bowels, especially in children,

or actual disease of the spinal centres or nerves of the bladder. In either case the result is a greater or less want of control over micturition, which may sometimes lead to difficulties of diagnosis. In most cases the presence of some organic nervous disease is obvious, but the early stages of such diseases as locomotor ataxy, disseminated sclerosis, and spinal caries sometimes reveal themselves first in a want of control over the bladder, which may be wrongly attributed to a purely urinary cause if the nervous system is not carefully examined. In children, irritability of the bladder and want of control, especially at night, are normal in early infancy and very common afterwards. Before ascribing them to purely reflex causes it is well to search for and exclude any possible organic cause. In the majority of cases there is some defect of nutrition which leads to a general nervous excitability, and in many cases the same condition is exaggerated by inheritance of neurotic tendencies from the parents. In such children habitual bed-wetting and uncontrollable micturition are easily excited or kept up by the irritation of worms or other disturbances in the alimentary canal. Children with postnasal adenoids are also very prone to this trouble. Local reflex causes should always be sought for, and if necessary removed, although the most important factor is not usually the reflex but the general condition of the nervous system.

When micturition is not only abnormally frequent but accompanied by more or less pain, one of three conditions is always present, namely:

(1.) Hyperacidity of the urine.

(2.) Inflammation of some part of the lower urinary tract or of adjacent organs—*e.g.* urethritis, prostatitis, and cystitis.

(3.) Obstruction to some part of the urinary outlet,

either spasmodic or organic—viz. stone, enlarged prostate, stricture, and new growths.

In some cases two, or even all, of these causes may be combined. We know that the mucous membrane of the whole urethra is sensitive to mechanical, thermal, and chemical stimuli. The passage of a sound, even when passed with the utmost gentleness, causes a disagreeable sensation, especially just as it passes through the sphincter and enters the bladder. If the manipulator is rough the sensation is one of acute pain, which is not very definitely referred to any particular part of the urethra, but radiates considerably, like most painful impressions. The effect of chemical substances such as caustic applications and of hot or cold instruments is to produce a similar sensation of pain. True local sensations of touch or of temperature distinguishable from sensations of pain appear to be absent from the mucous lining of the urethra. To what extent the mucous membrane of the bladder is sensitive to mechanical stimuli has not been fully investigated, and it is not easy to say how much the painful sensations caused, for example, by a stone in the bladder arise from the actual contact of the hard body with a sensitive mucous membrane, and how much from painful spasms excited secondarily in the muscles of the bladder. Probably both causes contribute to the causation of pain, although they cannot be clinically distinguished. It is certain that the mucous membrane of the urethra is more susceptible to painful impressions when it is inflamed, and the same is probably true of the lining of the bladder. These considerations will help us to understand the causes of painful micturition, which will now be discussed in clinical order.

Hyperacidity of the urine sometimes causes frequency of micturition, with a certain amount of pain in gouty adults, but much more often in infants and young children,

especially during dentition. In boys at such times the glans penis is red and tender, and the passage of the first few drops of concentrated urine causes acute pain, so that the child shuns micturition as long as possible. The symptom is often caused or increased by an excess of starchy food or an insufficiency of milk, and it disappears when this is remedied. It is often attributed to congenital phimosis, and treated quite needlessly by circumcision. True phimosis, with actual contraction of the preputial orifice, is comparatively rare, and when it does occur is invariably caused after birth by infective balanitis due to neglect of cleanliness. What is so often confused with phimosis is merely the natural adhesion of the prepuce to the glans which is found in every male child at birth. In this condition there is no organic contraction of the orifice of the foreskin, which can always be drawn back fully without the need of any cutting operation.

Of inflammatory causes of painful micturition, acute urethritis, generally gonorrheal, is one of the commonest. The pain is usually described as burning or scalding, and is felt along the whole course of the urethra. It is usually most intense at the beginning of making water. Micturition is not too frequent unless the inflammation has spread to the deep urethra or bladder, when there is more or less constant discomfort and desire to void urine according to the acuteness and severity of the inflammation.

Inflammation of the prostate and of the neck of the bladder, that is, of the trigone and sphincteric region, are practically inseparable, and are nearly always accompanied by more or less general cystitis. Consequently it is not always possible to discriminate between them by symptoms alone. The following considerations, however, are of some assistance in doing so. Painful impressions arising in the prostate are referred to the end of the penis, and are

usually most acute at the close of micturition—*i.e.* when the sphincters come into action and compress or pull on the prostate. When the whole prostate is inflamed, and especially when it is the seat of an abscess, dull aching pain in the perineum and rectum is present apart from micturition.

The pain of cystitis precedes micturition, and is due to the inability of the inflamed bladder to tolerate distension. As soon as a small amount of urine has collected pain and discomfort are felt above the pubis, and micturition can only be controlled with difficulty, or not at all. In other words the pain of acute cystitis precedes micturition, and is relieved by it, unlike that of prostatitis, which is just the reverse.

There is another common cause of painful micturition which, though it is not an inflammation of the urethra, is very similar in its character, namely, the common urethral caruncle of women. This should not be forgotten in searching for possible causes of this symptom, and can readily be detected by inspection.

Inflammations in the immediate neighbourhood of the bladder sometimes give rise to painful and frequent micturition. Peritoneal abscess in the pelvic region, of which the commonest example is that due to appendicitis, nearly always does so. There are also two affections of the lower ends of the ureter which almost constantly excite painful and frequent micturition, and which are important to bear in mind, since they are not readily detected. Of these one is impacted stone and the other tubercular infiltration. Probably in both the effect on micturition is due to inflammatory changes spreading into the bladder where the ureters traverse its muscular wall.

The pain of stone in the bladder is very similar to the pain described as prostatic; that is, it is usually felt at

the close of micturition, and referred to within an inch of the end of the penis. It seems, therefore, to be due to the contact of the stone with the empty bladder, especially the neck of the latter. It is often least marked with large smooth stones, and may be very great even when the stone is small. This suggests that impaction of the stone, or of a protruding part of it, into the urethra during the voiding of urine may be one of the causes of pain. Certainly rough and heavy stones, such as the ordinary oxalate of lime variety, are apt to be more painful. The pain of stone is distinguished from that of prostatitis by the effects of bodily movement or muscular effort in exciting pain apart from micturition.

The frequency of micturition in enlargement of the prostate has already been described. It is usually painless, but pain may be felt above the pubis at the beginning of micturition when the amount of obstruction is considerable, and is then due to the spasmodic contraction of the bladder endeavouring to relieve itself. When enlarged prostate has become complicated by septic cystitis or by stone, the pain of these conditions may be added, and may obscure or confuse the primary malady.

Similar remarks apply to the presence or absence of pain with stricture of the urethra. Micturition does not become frequent until the urethra is considerably narrowed and associated with some measure of thickening of the bladder muscle; it does not become painful unless the stricture is extreme or unless inflammatory complications, or false passages, are also present.

We will conclude by enumerating a series of questions by which the most important facts concerning disorders of micturition may be elicited.

1. Is there undue frequency of making water?
2. Is this symptom more noticeable by day or by night?

3. Is it affected by posture, by bodily movement, or by exertion?

4. Is there any pain on making water; if so, in what situation and at what part of the act?

5. Is there any alteration in the size or force of the urinary stream?

The significance of the various replies to these questions has already been discussed with the exception of the last, on which a few observations may be made. The size of the stream and the force with which it is expelled vary to a certain extent within the limits of health. It is usually freest and most forcible when the bladder is quite full, but when the latter has become over-distended the stream may be at first feeble and slow. The same condition may occur temporarily when the bowels are overloaded or distended with wind. When, however, the stream is habitually slow and feeble, some displacement or pressure on the bladder, or some obstruction at its neck—for example, enlargement of the prostate—may be suspected. When the stream is markedly diminished in size, and at the same time forcibly projected, stricture of the urethra is almost certainly present. In the most extreme narrowing of the urethra the urine, in spite of great effort and straining, may only be expelled drop by drop; the act of micturition is inordinately prolonged, and after it is apparently completed a considerable quantity of urine dribbles away and wets the clothes. This symptom strongly suggests stricture, being due to the considerable quantity of urine which runs away from the dilated urethra behind the stricture after the bladder itself has been completely emptied. When, on the other hand, the patient complains of wetting his garments at the beginning of micturition, *i.e.* when the desire to make water cannot be controlled, but is immediately followed by the act, this symptom is usually

due either to cystitis or to some defect in the nervous mechanism of the bladder.

We may now proceed to discuss the significance of another group of symptoms, namely, the complaint of pain referred independently of micturition to some part of the urinary tract. For practical purposes this consists only of various kinds of pain referred to the region of the kidneys and ureters, since pains referred to the lower urinary tract cannot be separated from the function of micturition, and have therefore already been considered.

"Pain in the kidneys" is one of the commonest complaints made by all sorts of patients, who mean by this a more or less acute pain across the small of the back, where popular anatomy locates the kidneys. The pain is often accompanied by the passage of high-coloured urine with a deposit of lithates, and patients may then complain also of passing "gravel" or "sand." Of course, these symptoms have in themselves nothing to suggest urinary disease. It may, in fact, be laid down as a safe clinical maxim *that renal pain can rarely be diagnosed unless it is unilateral.* Patients suffering from urinary disease may suffer from backache, a symptom common to many and varied illnesses, but it has no distinctive significance, and is probably never due directly to nervous impressions arising in the kidneys themselves. There is no direct evidence that the kidneys or the lining membrane of their ducts are sensitive to mechanical stimuli, any more than other viscera, such as the liver or the intestines, which may be touched or even cut without pain. Traction or movement of any of the abdominal viscera when exposed and handled in a conscious patient, especially when the traction or handling involves the parietal peritoneum or the mesentric attachment seems always to produce more or less acute pain. Visceral mucous membranes may be touched or

even cut without affecting consciousness, unless they are acutely inflamed, when mechanical stimuli probably, but not certainly, are capable of producing painful impressions. Distension of hollow viscera, when moderate in degree, produces certain reflex effects, together with vaguely localized and indefinite sensations; when the distension is increased to a certain point impressions of acute pain may be produced, which are referred either to the affected organ itself or to certain areas on the surface of the body corresponding with the somatic distribution of the spinal nerve-roots which supply it. These areas, which are known as the areas of referred visceral pain, have now been mapped out by physiological and clinical observations with considerable exactitude for each viscus.

They may be present in their typical forms without the co-existence of any pain referred to the corresponding viscus itself, as, for example, in hysteria. There may even be hyperæsthesia of the skin, and superficial tenderness to pressure in the painful area, which is quite distinct from sensations of pain caused by direct pressure on the affected viscus. This superficial tenderness must be distinguished from actual visceral tenderness. The so-called ovarian tenderness of hysteria, for example, is a true visceral referred pain, and not to be confused with the pain caused by direct pressure on an inflamed ovary. Light pressure on a normal viscus, for example the testes or kidney, gives rise to a peculiar sensation differing from ordinary pain, sometimes described as "sickening." More severe pressure produces both pain and general depression, with nausea or even collapse. When a viscus is inflamed or engorged with blood from interference with its circulation, it becomes both painful and tender, as is seen typically in the case of the testicle which, though a true abdominal viscus, is by an anatomical accident capable of direct observation. Lastly,

we have to note that all viscera which are muscular, or partly muscular, are liable to a variety of pain due to violent spasm, which may become very intense, and is referred, not directly to the affected part, but to its proper surface area of "referred pain."

The kidney consists of a mass of glandular tissue enclosed in a relatively inelastic capsule, in addition to its partial investment with peritoneum; it is supplied by large blood-vessels forming with the ureter a well-defined pedicle or stalk; and it is traversed throughout by glandular tubes and cavities ending in a single muscular duct. Owing to its anatomical structure, therefore, pain may arise in the kidney from a variety of pathological conditions: Inflammatory swelling of the whole kidney may produce increase of tension on the capsule. Strangulation of the pedicle by torsion or compression may cause the same result by leading both to vascular engorgement and to obstruction to the outflow of urine. Mechanical irritation of the mucous lining of the pelvis or calices of the kidney, by a hard and angular stone, may possibly be another cause of renal pain, although the pain of stone may be explained in other ways. Lastly, very severe pain may be due to the violent spasm of the ureter when engaged in overcoming the obstruction of a stone, blood-clot, or some fragment of tissue which has passed into its lumen. In any given case more than one of these factors may be operating, and it is not always possible to distinguish them. Speaking generally, however, *one-sided renal pain is usually due either to obstruction of urinary flow or hindrance to free circulation of blood.*

From the point of view of clinical symptoms, with which we are chiefly concerned, renal pains may be divided into the acute and chronic. Acute renal pain in its most typical form has long been known under the name of renal

colic, and is always due to obstruction and spasm in some part of the ureter, including the renal pelvis. The most familiar cases are those in which a calculus is the cause of the obstruction, but similar symptoms may be caused by sudden torsion of the kidney pedicle in cases of movable kidney. The pain in a typical case begins in the loin immediately below the last rib, radiates forwards towards the abdomen, and downwards through the iliac region and groin to the testicle, which may be drawn up during the pain by reflex spasm of the cremaster. In some cases where the pain is severe it may radiate to the outer and upper part of the thigh. It is always paroxysmal, often agonizing in its intensity, and is accompanied by nausea or vomiting, cold sweats, and considerable general collapse. Between the paroxysms pain may be absent, or the acute pain may be replaced by a dull fixed pain referred to the loin or iliac region, or groin. The position of this fixed pain is of some assistance in estimating the position of the stone in the ureter, since it is felt progressively further down in the course of the ureter when the stone is being successfully expelled. Pain presenting all these definite characteristics points clearly to the kidney, and is diagnostic even when no confirmatory evidence is found in the urine. Not all cases of renal colic present this easily recognized clinical picture. The paroxysms may be only subacute, and in patients who have passed numerous stones may be almost unnoticed. In such cases the most valuable symptoms in locating the cause of the pain are two; the radiation of the pain into the groin and testicle which is rarely absent to some degree, and the frequency of micturition which invariably accompanies acute renal pain. As has been already mentioned (page 4), this frequency is usually painless until the stone approaches the lower end of the ureter, when painful spasm of the bladder is apt

to be excited, and micturition becomes painful even before the stone has passed into the bladder.

Chronic renal pain may be continuous or intermittent: the former when the kidney is chronically distended from any of the causes mentioned above; the latter when the same causes act intermittently; for example, movable calculi, which temporarily obstruct the ureter and give rise to minor degrees of renal colic. Most commonly of all the two forms co-exist; that is, there is a greater or less degree of chronic pain or discomfort which is liable to be rendered acute by some temporary cause, such as posture, or muscular exertion, or increased secretion of urine. In many cases the kidney, without being spontaneously painful, is tender, *i.e.* pain is only elicited by bodily movement or external pressure. The clinical problem is first to determine whether the pain complained of has its origin in the kidney or some other source, and next to ascertain the probable nature of the disease. To distinguish renal pain from other pains somewhat resembling it is often a task of the greatest difficulty. The very acute form of renal colic presenting the clinical features described above presents no difficulty; but the less acute and typical forms, which are very common, are not easy to distinguish from other forms of visceral colic. On the right side simple intestinal colic, appendicular colic, cæcal colic, and biliary colic, give rise to radiating pains originating in the iliac, lumbar and hypochondriac regions. The pain of simple colic is seldom confined to one part of the abdomen, though it may be temporarily more intense where the wave of peristalsis is for the time at its maximum intensity. When the colic is due to definite obstruction of the lumen of the bowel the pain is often referred to the neighbourhood of the obstruction, especially in the case of the large bowel. But the most direct proof of the existence of intestinal colic is to

feel the hardening of the affected part of the bowel or watch the peristaltic movements during the height of the pain. When the abdominal walls are thin or atrophied this is often possible, but in most cases during acute visceral pain of any kind there is strong muscular rigidity of the abdominal wall which prevents any palpation of the organs within. The pain of appendicular colic radiates widely across the front of the abdomen from the centre of the iliac fossa; and the pain of biliary colic from beneath the ribs in the nipple line towards the epigastrium and navel and sometimes over the angle of the right scapula. Although the distribution of these pains differs from the typical form of renal pain the distinctions are seldom sufficiently precise to warrant a diagnosis; the most reliable points, when present, are the radiation of the pain into the testicle and the association of frequent micturition with the pain. On the left side visceral pains which are sometimes difficult to discriminate from renal pains arise in connection with the stomach and pancreas. The areas of referred pain of the stomach are well known and well defined, but those due to obscure affections of the pancreas and its neighbourhood are not easy to refer to their origin and have to be taken into account in diagnosing left renal pain. On either side inflammatory conditions of the ovaries and tubes may cause pains in the iliac region which may have to be discriminated from those of renal origin; and owing to the nearness of the bladder the diagnosis may be further complicated by the existence of some disorder of micturition. Abscesses, unconnected with the kidney but in more or less close proximity to it, may cause deep-seated pain in the loin or iliac region, resembling pain in the kidney; for example, psoas and iliac abscesses, having their origin in disease of the spinal column, sacroiliac joint, or pelvic bones. The writer has met with a case where such an

abscess actually burst into the bladder and gave rise to blood and pus in the urine. With or without abscess early spinal caries not infrequently gives rise to unilateral pains which may suggest kidney disease. Such pain may be due either to a deep abscess, or, more commonly, to irritation of the dorsal nerve-roots.

In all these various conditions little reliance can be placed on the character and location of the pain, and differentiation depends almost entirely on collateral symptoms. Distinct tenderness of the kidney, when the absence of muscular rigidity or the thinness of the patient permit it to be ascertained, is of decisive significance. The existence of palpable enlargement or excessive mobility of the kidney on the suspected side, or of some abnormal constituent in the urine, usually suffices to make the renal origin of the pain tolerably certain. *When neither of these collateral symptoms is present no positive diagnosis of renal pain can safely be made*, and even a provisional opinion can hardly be hazarded unless all the other causes of similar pain mentioned above have been negatived.

The nature of the disease, which is the cause of renal pain in any given case, cannot often be inferred from the character of the pain or the circumstances under which it occurs, but a consideration of these points is sometimes of assistance. A kidney which is the seat of constant aching pain, and which is also definitely tender to pressure, may be inferred with tolerable certainty to be either acutely inflamed or chronically distended with urine. Acute parenchymatous inflammation, *i.e.* acute Bright's disease, is not only almost always bilateral, but probably entirely different in its nature from an ordinary infective inflammation. At any rate, although the kidneys in this condition are greatly swollen and engorged with blood there is no acute renal pain or tenderness. In septic inflammation

of the kidney, the so-called surgical kidney, on the other hand, there is both pain and tenderness if the process is at all acute. Tubercular disease of the kidney generally gives rise to typical renal pain, and to more or less distinct attacks of colic as soon as blood or disintegrated caseous deposits begin to be discharged in the urine. New growths invading the whole or large areas of the kidney may exist without pain, but this symptom may be present when blood clots or pieces of growth are passed down the ureter. Calculus of the kidney is the commonest cause of typical renal pain, sometimes fixed and aching when there is chronic distension of the kidney from obstruction of the ureter or its branches, sometimes paroxysmal and colicky when stones are passing or attempting to pass downwards. There is nothing in the character of the pain to distinguish between these various causes, except that the most severe and typical attacks of renal colic are more often due to stone than to any other cause. The fact that the pain is apt to be exerted by abrupt movement or muscular exertion is common to all conditions in which the kidney is tender to pressure, and to many other causes of pain in the kidney region, such as abscess or spinal disease. The influence of movement and posture are, however, very important points to ascertain, especially in cases where undue mobility of the kidney is suspected to be the cause of pain. When the pain is excited not merely by jolting movements, but by stooping or straining or any effort capable of suddenly displacing the kidney from its normal position, the mobility of the kidney should be tested. The fact that the kidney can be felt by the examiner's hands to have a more than normal range of movement is not sufficient proof; but if, in addition, the pain or sensations of the patient correspond with the sensations elicited by handling and displacing the organ, this fact generally warrants a diagnosis. Many

extremely movable kidneys give rise to no symptoms whatever, and may be discovered accidentally in the course of clinical examination. On the other hand, severe pain on exertion may occur in cases in which no unusual mobility can be detected, either by clinical examination or during operation, and nevertheless the pain has been permanently relieved by nephrorraphy. The beneficial effects of the operation have been ascribed to mental suggestion in hysterical persons, and very likely with truth; but the writer has convinced himself by numerous experiences that this is not true of all cases, and that pain may be really due to displacements of the kidney, even when the range of movement is not demonstrably greater than normal. In the more extreme cases of movable kidney the symptoms may be quite objective and characteristic, namely, when the crises of pain correspond with a palpable enlargement of the affected kidney, and when the subsidence of the crisis is accompanied with the voiding of a large quantity of urine. In these cases there is chronic dilatation of the kidney or of the renal pelvis, and the symptoms are plainly those of intermittent hydronephrosis, due to periods of torsion of the pedicle. Movable kidney causing symptoms is rarely seen in men, and when found in women is much commoner on the right side. In most definite cases the symptoms are confined to one side. When both kidneys are found excessively movable—a common thing in neurotic women and those with lax abdomens—the pains and symptoms are much less definite, and the results of nephrorraphy much less satisfactory. In other words, real "movable kidney" as a surgical disease is always unilateral.

CHAPTER II.

ABNORMAL CONDITIONS OF THE URINE.

An examination of the urine, a necessary part of the clinical investigation of every case of urinary disease, may be made at any stage of the procedure. As a rule, it is convenient to make at least a preliminary examination of it before proceeding to the examination of the urinary organs, since by this means inferences derived from the symptoms may be corroborated, and the attention at once directed to the probable nature and seat of the disease. Abnormal conditions of the urine may be sometimes so striking and obvious as to attract the attention of the patient, who will mention them spontaneously or in reply to questions. Other changes may only be ascertained by a prolonged and exhaustive examination by all the means at our disposal. Not every case requires an exhaustive examination; but in order to avoid overlooking conditions which may be of great importance to the diagnosis it is well that the examiner should observe a systematic routine, even when the examination is not intended to be complete In the first place, the nature and contents of normal urine should be borne in mind and the limitations of every method employed not forgotten. By normal urine is meant here the fluid with all its contents passed naturally by a healthy person. In other words, we mean *the mixed secretions of the two kidneys together with any materials which may be derived from the normal ureters, bladder, urethra, and all*

glands opening into them. By various instrumental means which will be described in a future chapter, urine may be collected separately from different parts of the urinary tract and separately examined; but for the present we shall consider only the characteristics of the urine as it issues naturally from the bladder and the various diagnostic inferences which can be drawn from them. It must be borne in mind that what is usually examined for this purpose is merely a sample or specimen passed at a particular time; that the urine so passed may vary both normally and pathologically at different periods; and that the inferences must necessarily be limited by this fact. By collecting the whole urine for a given period and examining a sample of the whole, this source of fallacy may be diminished, but not excluded, since the urine may remain normal for long periods, and contain abnormal ingredients only at irregular and uncertain intervals. For this reason a negative examination of the urine has no absolute significance, and only becomes approximately trustworthy after repeated examinations. On the other hand, a positive finding, even if confined to a single occasion, is always significant, and may be conclusive when taken with other evidence.

Again, it is important to be sure that the urine contains no ingredients but those derived from the patient's own body, and is not mixed with any material or accidental impurity derived from an external source, such as atmospheric dust, materials derived from the patient's clothing, or from the vessel into which the urine has been passed or transferred. Specimens brought by the patient for examination have usually been passed into a chamber vessel, not always scrupulously clean and possibly used by several persons. From this, the urine is poured into a medicine or other bottle to which the same objections apply. It is

necessary, therefore, when any doubt may exist as to the nature of any abnormal ingredient discovered in a specimen of urine, to ensure that the urine to be examined is passed into a perfectly clean vessel and protected from chance contamination afterwards. For this reason it is also desirable that the specimen should be examined as soon as possible after examination, in order that putrefactive changes in the urine after leaving the body may be avoided. When a sample of the whole twenty-four hours' urine is required it is necessary for the same reason that special care should be taken to have the urine passed in sterile vessels and efficiently protected from dust.

For our present clinical purpose an exhaustive chemical and physical examination of the urine is unnecessary. What is required for preliminary diagnosis is a method which will recognize the more common and important abnormal conditions and enable us to draw from them correct inferences which can be applied to the case under investigation. Such a method may be summarized as follows. First, notice the smell, colour, and presence or absence of turbidity or visible deposit. Next, ascertain the reaction and specific gravity, and apply the ordinary clinical tests for albumen and sugar. The nature of any visible turbidity may be then roughly tested by warming a little of the urine in a test tube. If it is due to urates the cloudiness will disappear on warming. If it is due to phosphates it will clear on the addition of dilute acetic acid. If due to organic ingredients, such as blood or pus, the cloudiness will not clear up by either of these methods, and the deposit should then be *at once submitted to microscopic examination.* For the diagnosis of any case in which the urine contains visible ingredients microscopic examination is indispensable, and reliance should never be placed on chemical tests alone when the abnormal ingredients are

capable of being seen. Even diseases which are characterized by the presence of abnormal soluble bodies in the urine, such as albumen or sugar, may also betray their presence by accompanying cellular elements, and in all those diseases which are usually ranked as surgical, *i.e.* where there is local structural disease, the evidence of the microscope is, from a diagnostic point of view, of greater value than that of chemical tests. It is, in fact, a direct vision of fragments of tissue or other cells derived from the focus of disease, and it has the additional advantage in most cases of being both rapid and decisive.

We will now consider in more detail the various abnormal conditions of the urine, which may be recognized by the methods indicated, and afterwards discuss the significance to be attached to them when found.

The smell of the urine may reveal valuable information. Certain drugs, commonly used internally in the treatment of gonorrhea, such as sandal-wood oil, and others, impart to the urine a peculiar aromatic odour, which may give to an observant nose more information than a patient is always willing to impart. Small quantities of turpentine, taken internally, impart to the urine an odour said to resemble that of the violet; asparagus has an effect even more powerful, though less fragrant. Other examples might be cited, but such effects are curious rather than valuable. One fact of the greatest importance may, however, be readily and almost infallibly detected by smell, namely, the presence of putrefactive changes in the urine. Its significance, which depends on whether or not the changes have occurred within the body, is discussed below, but the presence of putrefaction should be noted, not only for its own sake, but for its possible effects on the chemical and microscopic examination. Those who have a keen scent and a good olfactory memory may sometimes recognize

particular odours associated with particular micro-organisms; for example, the bacillus coli, or the curiously offensive smell of putrid epithelial tissue, and the rotten fish-like smell of certain cases of cystitis and pyelitis. The highly ammoniacal smell of urine affected by the micrococcus ureæ is familiar to all, and is easily recognized. As a rule, however, the ordinary observer recognizes a putrefactive odour with certainty, without being able to describe it or to discriminate its special variety.

The reaction to litmus, a simple but important test, may be taken next. Normal urine, which is free from putrefactive change, is almost always acid. The degree of acidity may vary from the slightest possible reddening of the paper to a bright reddening, according to the concentration of the urine and the nature of the diet. The urine may be, even in health, distinctly alkaline, especially when the diet consists largely of vegetables or fruit, but any marked degree of alkalinity is abnormal. When the urine is undergoing decomposition by the micrococcus ureæ, which produces free ammonia from urea, the urine is of course strongly alkaline, and in fact most putrid urines are alkaline in reaction, but not all. There are certain micro-organisms which produce a putrid urine with a highly acid reaction, and reliance upon the reaction alone, as evidence against putrefaction, would be fallacious. As a rule, a recognisably putrid smell is sufficient evidence of putrefaction, even without microscopic confirmation. Apart from putrefaction, the reaction of the urine as an indication of the amount of acidity is of little importance for diagnostic purposes.

The specific gravity of urine is proportional to the amount of soluble contents of the particular specimen examined, and since the concentration of the urine varies normally from time to time, according to the amount and

nature of food and drink, bodily exertion, perspiration, and other circumstances, the specific gravity of a single specimen of urine may vary from 1001 to 1040 without any deviation from health. Abnormally concentrated urine is common also in fever from any cause, and abnormally dilute urine occurs in certain forms of Bright's disease as well as in diabetes insipidus. No inference can be drawn safely, as a rule, from the specific gravity of a single specimen, without being checked by measuring the total quantity for twenty-four hours. Simple concentration not due to any abnormal ingredient is, however, usually indicated when high specific gravity is accompanied by a high colour and a pronounced acidity of reaction. In such cases, for example, the concentrated urine of fever or of "liver derangement," there is usually present an excess of urates, which are precipitated as a pink deposit when the urine cools. When a high specific gravity occurs in a specimen of clear, pale urine, it is often due to sugar, the presence of which is easily demonstrated.

Simple inspection of the urine often reveals important facts. The amount of the normal pigment usually varies directly as the concentration, as just mentioned. The colour of the urine is easily altered by various drugs and pigments administered by the mouth or absorbed from the skin or wounds. Carbolic acid and iodoform in this way render the urine of a greenish colour, which becomes darker after standing. Methylene blue, given internally, stains the urine bright blue; fuchsin renders it more or less red. Eosin, in the same manner, imparts to the urine an opalescent character, easily recognized. Senna and rhubarb may render the urine brown or reddish brown. The vegetable pigments of bilberries, logwood, or madder, may have a similar effect when taken with the food. The possibility of deception must not be forgotten where

malingering or hysteria may be suspected, pigments being either designedly swallowed or added to the specimen of urine brought for examination. Blood may be added with the same motive. Natural pigments, derived from various morbid conditions of the system, may also appear in the urine and alter its colour. Apart from the presence of blood (which will be discussed separately), more or less altered hæmoglobin may appear separately in the urine and give it a reddish-brown colour. This condition is known as hæmoglobinuria. Lastly, in all forms of jaundice the urine contains bile pigments, or derivatives of these, which impart various depths of brown or greenish-brown coloration.

The first point to notice is whether the abnormal colour of the urine is due to a soluble or insoluble ingredient. If due entirely to the former the urine will of course be clear and translucent; if due partly or wholly to suspended matter it will be visibly turbid when held up to the light. If any doubt exists the urine must be allowed to settle or be centrifugalized or filtered. It can then be seen at once if the clear urine is of abnormal colour, and further tests can be applied to it if thought necessary. In medical cases it may be of the highest importance to determine the nature of the pigments present, and the methods for this purpose will be found in any work on clinical chemistry. For our present purpose, which is concerned with localizing urinary diseases only, the soluble pigments are important only for exclusion and the avoidance of fallacies. The most important thing to notice when inspecting a specimen of urine is, *does it contain any insoluble ingredient? If it does this ingredient is visible either to the naked eye or through the microscope* and its nature can almost always be determined best by these means.

The visible insoluble ingredients which may be found in the urine may be summarized as follows:

1. Various crystalline bodies such as uric acid and various urates, phosphates, oxalates, and carbonates, together with cystin, leucin, and tyrosin.

2. Certain of the above in an amorphous form.

3. Tissue elements derived from the body, namely blood, pus, chyle, epithelial débris and casts, spermatozoa, and fragments of new growths or disintegrated tissue.

4. Fungi and entozoa, either discharged from the body or adventitiously present from external contamination.

The methods by which these various bodies may be found and identified under the microscope need not be described here, as they will be found in any treatise on clinical examination of the urine. In some cases a simple examination of the sediment deposited from a specimen obtained in the ordinary way may find, either objects which are expected from the symptoms, or other unsuspected bodies which may open up a new line of investigation. In other cases, again, visible deposit may be absent or so slight in a single specimen that nothing is discovered by a simple examination. In such a case it may nevertheless be of the highest importance to determine the presence or absence of such bodies as blood, pus, or other cells; and then if necessary repeated samples must be examined, or a larger quantity of urine centrifugalized or filtered before satisfactory evidence, positive or negative, is obtained.

We will now consider in order the significance of the various abnormal conditions which have been alluded to, beginning with the first and one of the most important, viz. septic changes in the urine. Under this term is included for convenience all states of the urine in which chemical changes have been brought about by the action

of micro-organisms. Such changes have, of course, no clinical significance unless they occur while the urine is still contained within the body. This point is easily ascertained by having the specimen passed directly into a perfectly clean vessel and examining it immediately. If a fresh specimen of urine is thus examined and is found to be clear, acid, and free from offensive smell, it may be safely assumed that it is free from any of the ordinary germs of putrefaction. The presence of tubercle bacilli and of certain other pathogenic microbes is not, however, excluded by an acid reaction and the absence of a putrefactive odour, and unless present in very great quantity these will only be detected by microscopic examination of the centrifugalized deposit or by proper culture experiments. When the urine has become infected within the body by microbes introduced through the urethra it generally sets up inflammation of the lining of the urinary tract, which may be confined to the bladder (cystitis) or spread by the ureter to the kidney (pyelitis), and therefore septic urine almost always contains pus and much desquamated epithelium, in addition to a mixed bacterial flora in which cocci usually predominate. Septic urine may, however, be found in cases in which no instrument has ever been passed into the urine and in which there is no sign of cystitis. One kidney, for example, may contain pathogenic bacteria and discharge them together with pus into the bladder without altering the acid reaction of the urine or setting up cystitis. Although also pathogenic and putrefactive organisms may undoubtedly gain access to the bladder, especially in women, through a urethra which has never been catheterized, such an occurrence is unusual, and *when septic urine is passed from the bladder of a patient who has never had an instrument passed, there is a preliminary presumption in favour of some disease*

other than external infection. Beyond these few simple inferences little can be learned from the characters of septic urine until it can be determined whether the whole urinary tract is infected or only a portion, and if so what portion. The mere fact, however, of infection of the urinary tract is of the greatest importance to recognize, since it not only complicates the diagnosis and renders the detection of other abnormal conditions in the urine more difficult, but it also gravely influences both prognosis and treatment.

Blood in the urine, whether present in large quantity or merely enough to be discovered by the microscope, is always important and significant. Obviously the first point we wish to ascertain is, from what part of the urinary tract is the blood derived? The character of the urine does not often enable us to answer this question with certainty, but it often affords useful indications. *The time at which blood appears in the stream* should, if possible, be ascertained. If the urine is clear when first voided, and bloody towards the close of micturition the source of the hæmorrhage is almost certainly the bladder. This occurs most typically in villous tumour of the bladder, and is almost pathognomonic of this condition. When, on the other hand, blood appears at the very beginning of micturition and the urine becomes clear or less bloody towards the end, the source of the hæmorrhage may be inferred to be the prostate or deep urethra.

Blood uniformly mixed with the urine, especially when the tint of the mixture has a brown or smoky appearance, was formerly believed to be certainly of renal origin. The urine, it is true, presents these characteristics typically in the hæmorrhage which accompanies the early stage of acute nephritis; but brown and smoky urine with blood uniformly intermixed, may also arise entirely in the bladder

when the bleeding is slow and not very abundant. The colour and degree of admixture of the blood depend, in fact, merely on the time it remains in contact with the urine before it is passed; and although, therefore, the colour is likely to be darker and the mixture more intimate when the bleeding occurs in the kidney, the rule is by no means absolute. It is important to remember that when renal hæmorrhage is profuse, as, for example, in traumatic rupture of the kidney, the patient may pass bloody urine of a bright red colour, indistinguishable from that caused by an equally abrupt hæmorrhage of the bladder.

The presence of large irregular clots is another feature which was formerly held to point to a vesical origin of the blood, but the distinction cannot be relied on. It is true that large clots occur more frequently when the source of the blood is within the bladder; but it is not uncommon for blood passed from the kidney to clot within the bladder when the hæmorrhage is profuse. When, however, clots form in the ureter itself, they may be passed into the bladder and expelled from it while still retaining the size and shape of the tube in which they were formed. Such clots prove a renal hæmorrhage, for hæmorrhage in the ureter itself is so rare as to be negligible. The only clots with which they might be confused are those which occasionally form in the urethra, and in such case the other evidences of urethral hæmorrhage are generally clear. *Apart from ureteral clots, the only convincing evidence of the renal origin of blood found in the urine is the co-existence of renal tube-casts or of an amount of albumin largely in excess of the amount of blood.* Simple tube-casts of blood may occur in renal hæmorrhage from many causes, but when they are accompanied by epithelial casts and by an excess of albumin a diagnosis of nephritis is established. Similarly the presence of a typical fragment of villous

tumour found in the urine is sufficient to locate the hæmorrhage in the bladder, because although fragments of growth derived from the kidney may occasionally be found in the urine, they rarely or never have the characteristic structure of a bladder villus.

Intermittency of the appearance of blood in the urine is of little value in discriminating the place of origin, although much reliance was formerly placed on it. Periods of bloody urine, lasting for a few days, followed by longer periods during which the urine is quite clear, are of common occurrence in papilloma of the bladder; but they are by no means peculiar to this condition. On the contrary, a similar intermittency occurs quite as frequently in many forms of renal hæmorrhage, and the colour of the urine may be equally bright, since in such cases the hæmorrhage is usually abrupt and profuse.

The net result of these considerations is *that in only a few cases can the source of blood be determined from an examination of the urine alone.* In many of the commonest and most important cases in which hæmaturia occurs it is the only symptom, and we are quite unable to say whether the hæmorrhage proceeds from the kidney or the bladder. In some cases, although there may be nothing in the character of the urine to give any indication of the source of the blood, a clue may be found on palpating the abdomen or pelvis; for example, a palpable enlargement of one kidney, or of the prostate. But in the majority of cases the diagnosis cannot be made on symptoms alone, and must await a complete examination.

The possible causes of blood in the urine are very numerous, and it is necessary to be familiar with all of them, even those which are comparatively rare. Of those which affect the kidney, some affect both organs equally,

and others only a single kidney. If we include under the term "acute nephritis" all cases in which general œdema and uræmic symptoms are associated with the presence of much albumin and casts in the urine, and under the term "chronic nephritis" all those cases in which chronic uræmia occurs with little or no albumin—that is to say, all those diseases which are generally included under the name of Bright's disease, together with the various forms of toxic nephritis, we shall group together practically all forms of kidney disease which habitually affect both organs simultaneously. Hæmaturia may be a prominent symptom, both in the acute and in the chronic cases of this group. In acute nephritis the presence of an excess of albumin and of tube-casts, together with the general symptoms of the disease, make it easy to recognize the cause of the hæmaturia. In chronic nephritis, on the other hand, the general symptoms may be unobtrusive, and albuminuria slight or absent. Blood in considerable quantity may suddenly appear in such a case, and may present the greatest difficulty of diagnosis. Moreover, although, as has been said, all forms of Bright's disease, both acute and chronic, *habitually* affect both kidneys simultaneously, modern renal surgery has conclusively shown that *both acute and chronic nephritis may affect a single kidney independently.* Repeated attacks of hæmaturia may be the only symptom of a unilateral nephritis, either acute or chronic. Even when chronic nephritis is bilateral, a sudden urinary hæmorrhage, comparable to a sudden hæmoptysis, probably always proceeds from one kidney only. The importance of these facts is obvious. A diagnosis of "Bright's disease," merely from the discovery of a little blood and albumin in the urine, should not be made too hastily, for the abnormal ingredients may be derived from one kidney only; and therefore the case may be one calling for further investi-

gation and possibly surgical operation rather than purely medical treatment.

Every disease which habitually affects a single kidney may give rise to blood in the urine. In calculus, tubercle, new growths, hydronephrosis, pyonephrosis, movable kidney, traumatism, small or large bleedings may occur. In calculus and tubercle free hæmorrhage is exceptional; usually it is trifling, but microscopic blood is rarely absent from the urine in any case. New growths invading the whole kidney, like adenoma and carcinoma, may run their course without hæmaturia; but any growth which projects into the pelvis of the ureter or its branches produces hæmaturia, often very considerable in amount. A kidney abnormally engorged and dilated from any cause is liable to bleed into the urine, sometimes profusely or even dangerously. A contused or lacerated kidney bleeds more or less profusely according to the degree of injury. The bleeding may be intermittent and continued for a long period when a considerable vessel is torn.

Lastly, a single kidney may bleed profusely without displaying any recognizable lesion even when removed from the body and minutely examined. Many such cases have been recorded, and the name *essential renal hæmorrhage* has been given to the condition. The name is convenient, but, of course, adds nothing to our knowledge.

The presence of pus in the urine is proof of the existence of an inflammation of some part of the urinary tract, or of an abscess opening into it. *Its presence should never be assumed without a microscopic examination.* When the quantity is considerable it forms a deposit which is usually easy to recognize with the naked eye. Under the same circumstances the ropy viscous fluid is formed on the addition of liquor potassæ; but no reliance should be placed either on the naked-eye appearance or on such a

crude chemical test. Pus derived from the deep urethra and its follicles in cases of chronic gonorrhea may, however, be found in the urine in forms so characteristic as to be recognized by the naked eye when the urine is held up to the light. In some cases the pus forms thin flakes or "banners," exfoliated from granular patches in the urethra; in others it appears in the form of minute threads which have been compared to thread-worms, and which probably represent pus-casts of the urethral follicles. Although they may be recognized by the naked eye, it is well always to confirm the observation by the microscope. Apart from such pus-forms, there is no means of deciding from the character of the pus-cells themselves the part of the urinary tract from which they are derived. There are, however, certain features of the urine which sometimes throw light on this point. The presence of pus in acid, which shows no obvious sign of decomposition, suggests a renal origin. When the pus is also intermittent or varies greatly in quantity at different times, the probability that it proceeds from the kidney is increased. Indeed, a well-known clinical teacher used to tell his class that intermittent pus in acid urine meant pyelitis. The aphorism, however, requires much qualification. In the first place, urethral pus, usually gonorrheal, must be excluded. In women suffering from leucorrhea, pus from the vulva may be carried into a specimen of urine if precautions are not taken to avoid it. Although both these fallacies may be easily avoided, most surgeons have known pus found in acid urine to be hastily ascribed to pyelitis or some other lesion of the kidney. Again in tubercular ulceration of the bladder and perhaps in other forms of ulcer, the urine may be quite acid and aseptic. The only microscopic evidence which can be relied on to show that pus in urine is of renal origin is the finding simultaneously of renal tube-

casts. Even this conjunction is not infallible, since a nephritis may be complicated by cystitis or ulceration of the bladder, and the urine may contain cell elements both from the kidney and from the bladder.

When pus is found in urine which is decomposed, whether the reaction is acid or alkaline, it is impossible to decide the source of it from an examination of the mixed urine passed naturally. When the bladder contains putrid urine cystitis is usually, but not invariably, present; but the urine may be putrid in one kidney and therefore also in the bladder, while that in the other kidney is free from putrefaction, and in such a case it is impossible to say from the examination of the urine alone whether cystitis or pyelitis exists, or whether both may be present.

Of the other bodies which may be seen by the microscope in the urine, and which have been previously enumerated, little need be said. The crystals have, as a rule, little or no diagnostic value, since they occur very commonly, both in health and in numerous minor functional derangements. In cases of calculus crystals of uric acid and oxalate of lime are often found, and in some cases where they are very abundant they may be the only cause of frequency of micturition, or even, in children, of hæmaturia. Such a condition should, however, be never assumed unless all other evidence is negative.

The presence of the ova of bilharzia hæmatobia, or of the embryos of plaria sanguinis hominis is of decisive significance, and, in obscure cases of hæmaturia, the possibility of bilharzia should be borne in mind. Vegetable fungi such as saccharomyces (yeast) and various mould fungi are almost always derived from external contamination. It is important to be familiar with the forms of these, and with all the various microscopic objects which may be adventitiously present, otherwise they may be confused with

objects derived from the body. The writer has known cork-cells derived from the disintegrated surface of a bottle cork, prove puzzling objects in a urinary deposit, and there are many objects which may be mistaken for entozoa or their ova by unpractised observers.

So far we have dealt only with qualitative variations in the urine and their significance as regards the nature and localization of disease. It may, however, be of great importance to estimate the functional value of the kidneys as excretory organs in a particular case, and certain methods will now be described which help us to attain this object. If it were possible to fix a normal standard of daily excretion for the chief ingredients of the urine, all that would be necessary would be to collect the total urine of twenty-four hours in any given case, and to make a quantitative analysis for comparison with the normal. Such a method is not only too laborious for clinical use, but is of little practical value, owing to the wide variations in different individuals, and fluctuations in the quantities of the various constituents in the same person within the limits of health. Nevertheless, a quantitative determination of some of the more important constituents of the urine may be of great value in certain cases. The total quantity of urine collected in the twenty-four hours varies so greatly, according to the amount of water eliminated from the skin, lungs, and alimentary canal during the same period, that no inference can be safely drawn from the fact alone, without taking these facts into consideration. When, however, a patient, who is not febrile, not perspiring excessively, or suffering from diarrhœa or vomiting, and is ingesting an ordinary amount of fluid, passes a daily quantity of urine either much below or much above the normal, some deficiency or abnormal activity of secretion may be suspected. Normally, also, the kidneys respond very rapidly

when an unusual amount of fluid is ingested, and the so-called physiological polyuria which results may be used as a clinical experiment. If copious drinking of water is not followed in a short time by a proportionally copious secretion of urine, or if the polyuria is delayed in its appearance, the test so far as it goes indicates some failure of renal activity. The total quantity of twenty-four hours' urine may of course contain a greater or less than ordinary amount of total solids. The specific gravity of the total quantity is a rough indication of the total quantity of solids, and therefore enables us to decide whether the solids are increased or diminished proportionally to the water or not.

Another method of gauging the total solids has been recently introduced and named cryoscopy; that is, the determination of the freezing point. The freezing point of a watery solution is lower than that of distilled water, in proportion to its molecular concentration. That of normal urine lies according to Koranyi between $-1{\cdot}30°$ and $-2{\cdot}20°$; but when the patient has drunk much, or perspired, may vary from $-1°$ to $-2{\cdot}30°$ and more. The freezing point for this purpose is conveniently expressed by the symbol Δ.

Obviously even when determined for the total urine it does not give more precise information than the density, except that it indicates the total dissolved molecules independently of their nature. Efforts have been made to obtain reliable indications of the functional power of the kidneys by combined observation of the freezing point and other factors, such as the quantity of sodium chloride, and the effect of the ingestion of chloride on elimination, but the results cannot be relied on. Since the molecular concentration of a solution determines its osmotic pressure, the state of renal activity influences the osmotic pressure both of the blood and of the urine. Consequently the

determination of the freezing points of the blood may be expected to throw light on the urinary function. When the kidneys are acting properly the molecular concentration of the blood is maintained at a point which is tolerably constant—viz. — 0·56°. The value of this observation is affected by the fact that the freezing point is altered by various pathological states, and by diet, independently of any affection of the kidneys. After making due allowance for these facts Kummel asserts that a fall of the freezing point of the blood to — 0·58 or — 0·60 is a proof that both kidneys are acting insufficiently, for a single kidney doing its normal work will keep the freezing point from falling below — 0·56. He states also that when the freezing point of the blood is normal there is no general disturbance of the renal function. These assertions have been disputed by other observers, and although the method of cryoscopy promises possibly to be of value in the future, for the present it cannot be recommended for general clinical use, whether applied to the blood or to the urine.

Estimation of the daily output of urea, or of the total nitrogen, is a comparatively simple chemical operation, and is still the best method available for gauging the functional value of the kidneys in a given case. A marked deficiency of urea points generally to a failure of renal activity, although it has been shown by J. R. Bradford that a high or even excessive daily excretion of urea occurs in some forms of advanced Bright's disease. Allowance must also be made for the effects of fever and of diet in influencing the daily output of nitrogen.

Another method of considerable value is known as the methylene-blue test, which consists in watching the rapidity and completeness with which methylene blue when injected intramuscularly is excreted in the urine. Fifteen minims of a 5 per cent. solution are injected, and the bladder

emptied at the same time. The urine is collected half an hour later and then at hourly or longer intervals until the blue tint disappears. Since the pigment is sometimes eliminated in the form of a colourless chromogen, if the urine is not coloured when passed, a specimen should be boiled with a few drops of acetic acid. If the chromogen is present the urine then immediately turns blue. In a normal person the colours should be found from half to one hour after the injection. A delay in the elimination points probably, though not certainly, to a bilateral lesion of the kidneys. The intensity of the blue coloration in proportion to the total quantity of urine passed is a measure of the sufficiency or insufficiency of renal function, especially in surgical diseases of the kidney. In parenchymatous nephritis the test is less reliable, for the blue may be well eliminated. In cases of pyelonephritis and surgical kidney, according to Albarran, the pigment is apt to be eliminated largely as a chromogen, so that the blue colour is only brought out by boiling with acid. The course of elimination is sometimes intermittent, even in the case of a single kidney after nephrectomy. This is held by Albarran to be a sign of compensatory hypertrophy. The duration of elimination in a healthy subject is from 35 to 60 hours, and it may be prolonged beyond this period both in urinary diseases and in compensatory hypertrophy. An excessively rapid and short elimination with intense coloration has been observed in cases of parenchymatous nephritis, pointing to an exaggerated permeability of the kidneys. The subcutaneous injection of the substance named phloridzin causes glycosuria. This fact has been used as a test of renal function. One c.c. of a ·5 per cent. solution is injected after ascertaining the absence of sugar from the urine. Sugar appears in about half an hour and lasts from two to four hours. The quantity eliminated is from 1 to

2 grammes, more than can be derived from the decomposition of the phloridzin injected. The sugar is formed in the kidney and not in the blood. The greater or less quantity of sugar eliminated in the urine constitutes the test. The value of it for chemical purposes is a subject of dispute.

For cases of bilateral kidney disease, in which it may be desired for any purpose to determine the total functional value of the kidneys, the various methods described may be used with advantage; but for the purpose of comparing the functional value of the two kidneys with each other, an object often necessary to the surgeon, more direct means are provided by separating the two urines in the manner described hereafter. The methods of artificial polyuria, cryoscopy, estimation of urea, methylene blue, and phloridzin, when combined with separation of the urines, give results of incomparably greater value and precision.

CHAPTER III.

PHYSICAL EXAMINATION OF THE PATIENT AND OF THE URINARY ORGANS.

THE information derived from the consideration of a patient's symptoms and from the analysis of the urine may in some cases enable a diagnosis to be made without further investigation. If, for example, he complains of headache and morning vomiting, and his urine contains albumin and tube-casts, the presence of some form of nephritis may be assumed. In other cases the symptoms and state of the urine may render a particular diagnosis probable, though not certain; for example, a typical attack of acute renal colic, accompanied by blood in the urine, strongly suggests stone. In the majority of cases of urinary disease, however, symptoms, including the state of the urine, are insufficient of themselves to indicate the nature and seat of the disease; they merely permit us to frame a provisional diagnosis, or to suggest various possibilities. In order to complete the diagnosis it is necessary in every case to make some kind of bodily examination. The extent and thoroughness of this examination vary in individual cases. When a simple examination shows clearly the nature of the case, it is not always necessary to put the patient to the trouble and inconvenience of a systematic examination by every possible means. The investigation in such a case need only be pursued far enough to establish the diagnosis clearly and beyond the possibility of serious

error. Summary methods of diagnosis should, however, be adopted with caution, and only by those with ample clinical experience. Even competent men may be betrayed into serious errors by jumping too hastily to conclusions, and by omitting to verify their assumptions. For those of less experience it is well to pursue a definite routine in examining a new case, in order to avoid overlooking facts which may have an important bearing. Even negative facts may be of great importance, and in a routine examination they will hardly escape notice. Lastly, it must be remembered that a much greater degree of accuracy and precision is now possible in urinary diagnosis than was formerly the case, and is therefore required and expected from all who undertake the treatment of urinary diseases. Their maxim should be that local disease is capable of local diagnosis and local treatment, in whatever part of the urinary tract it may happen to be.

The object of physical examination is to determine the presence or absence of structural disease by direct observation. When disease affects the external organs which can be exposed to sight and touch the task is simple. The nature and character of a malformation, new growth, or venereal inflammation of the external urinary organs seldom present any difficulty of diagnosis, if the parts are carefully examined. Since for reasons of modesty or shame a patient may not mention all his symptoms, or may even be unaware of them, an external examination should never be omitted in a case of any obscurity. The presence of signs of gonorrhea or of a simple urethral caruncle may at once explain symptoms which might otherwise be wrongly referred to other causes. Again, simple inspection of the body may at once reveal to a practised eye the presence of œdema of some part, such as the face, the scrotum, or the legs, or even the presence of a visibly distended bladder.

An ordinary medical examination of the heart, pulse, and chest may discover signs of hypertrophy of the left ventricle, a high arterial tension, or fluid in the pleura, the significance of which with regard to the state of the urinary organs would be immediately recognized. An ophthalmoscopic examination not unfrequently reveals conclusive evidence of advanced renal disease. A special familiarity with diseases of the urinary system must not imply an ignorance or disregard of the cardinal facts of general medicine and general surgery. It is assumed, on the contrary, that a general examination of the body by ordinary clinical methods, more or less complete, according to the case, is an essential preliminary to the more detailed investigation of the urinary organs and functions.

The first step of such an investigation after the inspection of the external organs consists of an ordinary clinical examination of the abdomen, in which, while not omitting to note the condition of all the abdominal viscera, special attention is paid to the bladder, the kidneys, and the course of the ureters. In an abdomen of moderate size and fatness, when the muscles are properly relaxed and the patient is allowed to breathe easily and deeply, it is usually easy to feel the bladder when moderately distended, and when greatly distended it may form an obvious elastic tumour in the hypogastrium. In acute cystitis there is generally marked tenderness on deep pressure above the pubes, even though the bladder contains little or no urine. The course of the ureter may be felt on deep palpitation, and in thin subjects it may even be possible to feel the ureter itself as it crosses the brim of the pelvis, if it is inflamed and tender, or if it contains a calculus. The normal kidney can seldom be felt in a man of ordinary stoutness, but in women, as it is less covered by the ribs, and the abdominal walls are often relaxed, it may often be felt, especially on the right side.

Even when the kidney is considerably enlarged it is often not possible to feel it, owing to the projection of the ribs and its depth from the surface; but when the kidney is definitely tender to pressure, whatever its size, it is nearly always possible to elicit pain by pressing the thumb deeply in the loin in the angle between the twelfth rib and the outer border of the erector spinæ. When this symptom is definitely elicited, especially when there is a marked tenderness in one loin only, this is a symptom of great value. When an enlargement of the kidney reaches a sufficient size to be felt as an abdominal tumour there may be some difficulty in distinguishing it from other abdominal tumours: for example, on the right side, hydatid or other tumours of the liver, inflammatory or malignant masses surrounding the gall bladder, pylorus, or cæcum; on the left side, tumours of the spleen or descending colon; and on either side tumours springing from the ovaries or uterus, and certain retroperitoneal sarcomata. The essential features of a renal tumour are, first, that it is anchored by a pedicle which is always attached, however long it may be, to the place of origin of the renal artery, and secondly, that it is always capable of being pushed into the normal seat of the kidney beneath the last three ribs, even if it happens to be freely movable. This feature distinguishes renal tumours both from those of the lower region, which are attached in an upward direction, and from those of the pelvis, which have their fixed point below. Another distinguishing feature of renal tumours is that they invariably lie behind the colon, owing to the retroperitoneal position of the kidney. Consequently when a large renal tumour expands it pushes the small intestines to the inner side of the abdomen, but the colon remains fixed to its anterior surface, and may be recognized by palpation or percussion, as a hollow resonant organ

resting on a mass which, being always fluid or solid, is relatively dull.

Abnormal mobility of the kidney is easily recognized when the organ is enlarged or distended, but much less easily when it is of normal size. The mobility may be almost startling in its range, when the pedicle is long, and the peritoneum over it very loose; it may be pressed and followed in some cases almost into the pelvis, across to the opposite flank, and upwards and forwards into the epigastric region. From this extreme degree of mobility all degrees are found down to the normal, which consists merely of a slight upward and downward movement with deep respiration or with variations of posture. The degree of mobility which may be called abnormal, depends upon the symptoms in individual cases which have already been discussed (page 18).

Bimanual examination enables us to palpate the deep urethra, the prostate, the bladder, and the extremities of the two ureters; and incidentally to discover any palpable abnormality of the other pelvic organs. When conducted under an anæsthetic with complete relaxation of the muscles and with the bladder emptied, bimanual touch is an extremely accurate means of discovering any localized hardness or enlargement in any part of the lower urinary tract, such as an abscess or stricture of the urethra, enlargement of the prostate, stone, or tumour in the bladder, or stone in the lower end of the ureter. In infants and young children bladder stone c n almost always be recognized by bimanual palpation through the rectum, and by the same means in a young child, contents of the whole lower half of the abdomen can be thoroughly brought between the two hands, even without an anæsthetic.

Instrumental examination of the urinary organs is usually relegated to the surgeon, and if urinary diseases

are to be arbitrarily divided between the physician and the surgeon, all those which require the use of instruments for their treatment may be conveniently classed as surgical. For diagnostic purposes, however, it is necessary to remember that no such division is possible. Exact diagnosis, *i.e.* the precise localization of the disease, is often impossible without the use of examining instruments. The physician who knows nothing of urinary surgery and the surgeon who is ignorant of medicine are alike incompetent to diagnose a difficult case of urinary disease. The catheter, the sound, and the cystoscope are as indispensable in urinary diagnosis as the stomach tube or the ophthalmoscope are in diagnosing diseases of the stomach or of the eye. The use, however, of even the simplest urinary instruments involves a danger which is absent from other methods of clinical examination, namely, the risk of introducing the germs of putrefaction into the urinary cavities. This danger is so great, and even now so little appreciated by the majority of practitioners, that it cannot be too much emphasized. A doctor who is unable or unwilling to take the precaution necessary to avoid this risk should never attempt to pass an instrument. Nothing is easier than to infect the urinary tract, nothing is more liable to the most disastrous consequences, and nothing is more difficult to eradicate afterwards. The danger is present even when the urinary organs are normal, but it is increased many times when there exists any condition which hinders the free evacuation of the urine, or when the presence of blood or albumen in the urine affords a favourable soil for micro-organisms. The commonest and most familiar examples of the evil effects of infection by instrumentation are seen in enlargement of the prostate, with incomplete emptying of the bladder, and in bleeding tumours or ulcers of the bladder. In either of these cases a septic cystitis may be set up, which either compromises

the success of an operation, or directly leads to a fatal result after a period of chronic misery.

Before describing the means of avoiding these untoward results, it may be pointed out that when the diagnosis is clear beyond doubt, from the symptoms and the state of the urine, instrumentation is unnecessary, and should be avoided altogether. Or again, it may be clear from the symptoms that the case is one which will probably or certainly call for surgical treatment. In such a case it is a good plan if possible to postpone all instrumentation until immediately preceding the operation, which the result of the examination may make necessary. For instance, where the symptoms point to a tumour of the bladder, the existence and character of it, if present, may be determined by the cystoscope when the patient is anæsthetized and prepared for operation. In this way, not only is it easy to exercise all the precautions necessary to ensure asepsis, but there is completely avoided any chance of having to operate in a field already infected by a previous instrumentation. The same consideration applies to operations for stone. Whether the presence of the stone be determined by the sound or the cystoscope, the sooner the operation follows the establishment of the diagnosis the better for the patient's chances.

This practice, however, cannot always be followed. It is often necessary for reasons of convenience, or to convince the patient, to clinch the diagnosis in the consulting-room by the use of the catheter, the sound, or the cystoscope; and, under these circumstances, it is necessary to employ the same precaution as surgeons use in operations to prevent the introduction of germs. The first and most obvious precaution is to employ only instruments which are capable of being easily and effectively sterilized. For this reason it is well to dispense entirely with all hollow instruments of a material which cannot be boiled. It is

possible to sterilize a smooth metallic instrument, such as a bladder sound or a well-made cystoscope, by washing and wiping carefully with antiseptic lotion; but a catheter, on account of its interior, can be quickly and certainly sterilized only by boiling, and should therefore be made either of metal or of a material capable of being boiled without losing its smoothness or elasticity. Although flexible catheters of the "gum-elastic" variety are now made capable of being boiled, they soon lose their polish, and it is better to avoid them. For all practical purposes for which a flexible catheter is required, the pure rubber catheter known by the name of "Jaques" answers perfectly; and where a catheter with a variable curve is required, the same catheter can be used with a wire stilet. There is no catheter which slips so easily either into a normal bladder or through an enlarged prostate as the rubber catheter. Where it fails—for instance, in cases of stricture—metal catheters, which can be boiled, should always be preferred to flexible instruments which cannot be boiled.

The cause of contamination may, however, be found not on the instrument, but in the lubricant applied to the instrument, on the surgeon's hands, or on the orifice or outer part of the patient's urethra. Both of the latter should be cleansed and wiped with an antiseptic wash. The normal urethra within an inch of the orifice may be assumed to be practically sterile; even where urethritis exists in the anterior urethra, germs are not often carried by an instrument beyond the constrictor urethræ, though the risk does exist and should be borne in mind. The oily lubricants so often used should be entirely discarded; their sterility cannot be relied on, even when they contain antiseptics, and owing to their insolubility in water they are difficult to remove. Glycerine containing 5 per cent. of

boric acid makes an excellent and quite reliable lubricant, and is, of course, freely soluble in water, and therefore easily got rid of. Finally, when an instrument has been passed into the bladder for any reason, it is a good plan to administer urotropin or some other urinary antiseptic for forty-eight hours afterwards to counteract any chance infection.

The first purpose for which instrumental examination is necessary is to determine the calibre and patency of the urethra. For this purpose the best instrument to begin with is a rubber catheter of No. 8 to 10, English scale. If this instrument can be passed right into the bladder, the urethra may safely be assumed to be normal. It is true that the normal adult urethra is capable of taking an instrument many sizes larger than No. 10, and that the passage of an instrument of this size does not logically exclude the existence of slight degrees of contraction. If any doubt is felt on this point a larger instrument of metal may be passed for confirmation; but it is seldom necessary, because it may be taken for granted that a *perfectly flexible* instrument cannot be passed except through a urethra considerably larger or more extensible than itself. It will be found that a urethra which is strictured or contracted to a size which will only admit a rigid instrument of No. 8 cannot be traversed by a rubber catheter of that calibre. This being so, unless the patient is under an anæsthetic there is no advantage of putting him to the greater pain of passing a full-sized metal instrument. If, however, the rubber catheter fail to pass, it must not be assumed that the urethra is contracted. The mucous membrane may be inflamed and rough, or the catheter may not be quite smooth or sufficiently lubricated. Again, the urethra, although of undiminished calibre, may be elongated and tortuous from enlargement of the prostate

or from displacement by an abscess or tumour, or there may be spasm of the anterior sphincter of the urethra. All or any of these causes may offer a resistance which the small amount of force capable of being applied through a perfectly flexible catheter may be unable to overcome. When this is the case the calibre of the urethra can only be determined by passing a full-sized *rigid* instrument. It may be assumed that neither friction nor spasm will prevent the passage of a full-sized rigid instrument if the urethral calibre is normal. Even tortuosity or displacement of a full-sized urethra rarely prevents the passage of such an instrument, if skilfully used and appropriately curved.

There is one other cause, apart from stricture, which may lead to difficulty in passing an instrument into the bladder, namely, the existence of pouches or false passages in the urethra. The former may arise from the bursting of an abscess into the urethra; the latter can only arise from injury, either due to external accidents or to previous unskilful instrumentation. If the urethra is not contracted the presence of a false passage is no bar to entering the bladder with a full-sized rigid instrument, of which the point can be made to keep close to the roof of the urethra throughout its course. The reason for this precaution is that false passages and diverticula almost always leave the urethra at its floor or side.

It is of the utmost importance to determine the nature of the obstacle in any case in which difficulty is found in passing an instrument into the bladder. It is not uncommon to find the difficulty hastily ascribed to "spasm" or stricture, when it is in reality due to want of skill, or to some condition quite different from stricture. The following rules will help to avoid errors of this kind. In the first place do not hastily assume that a patient who

complains of difficulty in voiding urine probably has a stricture, and, even if there is some reason to suppose so, do not begin by passing a small instrument. Small catheters or bougies are specially liable to be arrested by false passages, or even by folds and pockets in the mucous membrane, and so fail to enter the bladder. Always begin by a well-lubricated rubber catheter of not less than No. 8 English. If this fails to pass, try a metal sound or catheter of the same size. If this also fails, note the distance at which its point is arrested. If at the bulbo-membranous junction, or on the distal side of it, *i.e.* usually within six inches of the meatus, a stricture or false passage is possible; if beyond this point, stricture may be excluded, for it is rarely, if ever, found beyond it. If any difficulty occurs in entering the bladder after traversing the membranous urethra, it will be generally found to be due either to want of skill in handling the instrument, or to enlargement of the prostate, and corresponding lengthening of the urethra with upward displacement of the bladder. This condition seldom offers any difficulty to the passage of a smooth and well-lubricated flexible rubber catheter, which accommodates itself automatically to the curves of the urethra. A rigid instrument of 8 to 10 English calibre can also usually be introduced, by giving it a much longer curve than the ordinary, and by depressing the shaft well between the legs so as to carry the point upwards towards the bladder. When the bladder can only be reached by an extra long and fully curved instrument used in this manner, enlargement of the prostate may be diagnosed. The diagnosis may be confirmed by rectal palpation in many cases, but not in all, since the obstruction may be due mainly or entirely to enlargement and projection of the prostate within the bladder, an enlargement which cannot be felt per rectum. In such a case measurement of

the length of the urethra by means of the catheter, to be described later, fails to demonstrate the condition, since the intravesical portion of the prostatic urethra may contain urine. It is possible, however, in such a case to prove that the prostate is enlarged, by bimanual palpation with one or two fingers in the rectum, while the beak of the sound is held downwards behind the prostate in the manner shown in fig. 1. By this means the existence and amount of

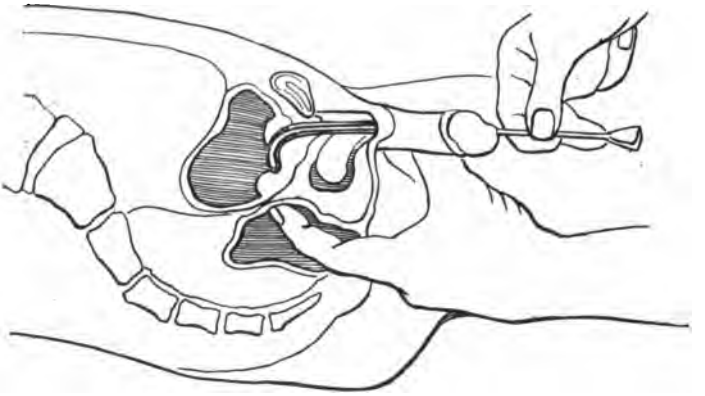


FIG. 1.—Combined Examination of Prostate.

enlargement can be determined in any case with considerable precision. Since the calibre of the urethra is never diminished, although it may be laterally compressed, by enlargement of the prostate, it is a good rule never to use any but large instruments whenever an obstacle is encountered beyond the membranous urethra.

In any case where the obstacle is encountered beyond the membranous urethra, never use any but large instruments, since they pass more easily, and are less liable to enter or make false passages.

In order to demonstrate the existence of a stricture (*i.e.* of an organic narrowing of a part of the urethra, for

so-called spasmodic and inflammatory strictures are incapable of preventing the passage of a normal-sized instrument, and may therefore be disregarded) it is necessary to pass successively smaller and smaller instruments *until one of them succeeds in passing through the stricture, and can be felt to be more or less tightly gripped by it.* This proves not only the existence of a stricture, but its position and calibre. The mere arrest of the examining instrument at a spot near or in front of the bulb (the common position of most strictures) *must not be accepted as a proof of stricture.* The difficulty may, in unpractised hands, be merely due to the change in the direction of the urethra where it enters the triangular ligament. Apart from this source of fallacy, the instrument may be brought to an abrupt stop because its point is in a false passage. This fact is usually indicated by free hæmorrhage when the false passage is made by the examiner himself, less free, but still seldom absent, when the instrument reopens the track of an old laceration.

Attention to these points will enable the calibre of the urethra and the nature and position of any obstruction of it to be determined with certainty in every case, but it must not be thought that the task is always an easy one. Mistakes are constantly made, even in distinguishing between two such common and radically different diseases as stricture of the urethra and enlargement of the prostate. In some cases the distinction is easy, and can be made in a few moments; in others, considerable skill and prolonged instrumentation may be required to establish the diagnosis. In such cases a general anæsthetic should be employed, and the whole procedure carried out under conditions which permit the most rigid precautions against sepsis.

Whether obstruction of the urethra is caused by enlargement of the prostate or by organic stricture, and

whether it is partial or complete, the patient is often in urgent need of relief. When the prostate is at fault it is very seldom that the bladder cannot be relieved by catheter, if proper methods are used. In tight strictures, on the other hand, especially when complicated by false passages and perhaps external sinuses, although no case is truly impermeable, much time, patience, and skill may be required to traverse the stricture successfully even with the finest instrument. Skill and patience will almost always eventually succeed in doing this, but as the need of relief is urgent, it is pedantic and foolish to persist over-long in attempts of this kind. It is far better to establish the diagnosis and complete the treatment by a single operation, not by the tedious and uncertain operation of Wheelhouse, but by exposing the membranous urethra behind the stricture, where it can be always found with certainty, its position being unaffected by the inflammatory changes in the structures anterior to it.

So far, no distinction has been made except incidentally between the use of solid and hollow instruments in testing the calibre and permeability of the urethra. For this purpose solid instruments would, if necessary, suffice; they have, moreover, the advantage of being more easily sterilized, and therefore of lessened risk of infection. The catheter, however, as an instrument of diagnosis, and quite apart from treatment, has several important advantages over a solid instrument. In the first place, it enables us to be certain that the instrument has really reached the bladder and is not merely in a false passage or the pre-vesical space, as may occur with a sound in a difficult case of stricture, or a case of traumatic rupture of the urethra.

Secondly, it furnishes a tolerably accurate means of measuring the total length of the urethra, since the point at which urine begins to flow when it is introduced, or

ceases to flow when it is withdrawn, marks its entry into the bladder, and the length of the urethra is given, therefore, by the length between the eye of the catheter and the external meatus. The importance of this measurement is considerable, since the only condition in which the urethra is perceptibly lengthened is enlargement of the prostate. The prostatic urethra, which is nominally $1\frac{1}{4}$ inch in length, participates in the enlargement of the prostate, and is proportional to it when the enlargement is uniform and not confined to lobular projections within the bladder. Since the prostate may be increased to two or three times its natural size, the prostatic urethra may be lengthened in extreme cases by several inches. If, therefore, the total length of the urethra in any case exceeds the normal $8\frac{1}{4}$ inches, by an amount which cannot be accounted for by any unusual length of the penis, enlargement of the prostate is probably the cause.

Lastly, the catheter enables us to discover the existence of "residual urine" in the bladder, *i.e.* urine which cannot be voided by voluntary effort. When a catheter is passed on a normal person immediately after he has voided urine, the bladder is found to be empty, except for a few drops. When the prostate is enlarged in a degree or manner sufficient to interfere with micturition, sooner or later the bladder becomes incapable of completely emptying itself, and then "residual urine" can be drawn from the bladder by the catheter immediately after micturition. The amount left behind varies with the degree and duration of the obstruction, from a few ounces to several pints. In the latter case the bladder is chronically distended, perhaps to several times its normal size, and the patient is only able to get rid of its normal daily quantity by passing a few ounces at a time at very frequent intervals, the distended bladder being unable to tolerate more than a very small

addition to its contents. The final stage of this condition is reached when, all power of voluntary micturition being lost, the urine dribbles constantly away, and a condition resembling complete incontinence results. This is called "retention of urine with overflow," and, of course, it differs essentially from the form of incontinence in which the bladder is unable to retain its contents at all. The presence of residual urine of more than an ounce may be taken as evidence of prostatic trouble. Usually confirmatory evidence will be easy to find by rectal palpation, or by measuring the urethra, or, failing these, by cystoscopic examination. It is, however, necessary to know that all the symptoms of prostatic difficulty may occur in patients in whom the prostate is not enlarged, although it may be altered in structure. In such cases the principal evidence will be the finding of residual urine by the catheter.

Any form of metallic instrument used in examining the urethra may also serve to explore the interior of the bladder. The ordinary curve given to urethral instruments is not, however, convenient for this purpose, and a special instrument is generally employed, the bladder sound, which is distinguished by a short extremity or beak of an ovoid or bulbous form, somewhat abruptly curved, and of larger calibre than the shaft. It is specially designed for recognizing the presence of a calculus either by touch, or by the distinct clinking sound which can be heard when a stone is smartly tapped. It serves also for the recognition of any unusual roughness or resistance in the wall of the bladder and sometimes for the discovery of abnormal pouches or recesses in its cavity. A growth occupying any considerable part of the bladder space may sometimes be recognized by the sound, or its presence may be suspected if even the gentlest manipulation is followed by hæmorrhage. As a general means of exploration the sound is now super-

seded by the cystoscope, but it still remains the most simple and rapid, though not the most certain means of detecting stone in the bladder. As a rule there is no difficulty of bringing the sound into contact with the stone, and then tapping it by a quick rotatory movement of the shaft. A clear sound heard is unmistakable, and even the feel of a stone can hardly be mistaken by any one who has once felt it. Nevertheless there are certain sources of fallacy which may deceive the inexperienced, or may render the detection of a stone impossible by means of the sound alone. A rough grating sensation felt as the beak of the sound passes over the projecting muscular bands of a hypertrophied bladder may be mistaken for a soft stone; an error generally of inexperience, but not an uncommon one. More commonly the sound, for some reason, is never brought into contact with the stone itself. The beak may never really enter the bladder, but remain in the prostatic urethra, where a certain amount of movement from side to side is possible and so give the impression that the bladder is being sounded. In order to avoid this fallacy the shaft should be well depressed between the legs so as to carry the point upwards into the bladder. If any doubt remains palpation of the sound by a finger in the rectum will easily determine its real position. Difficulty may arise from the position which the stone occupies in the bladder. Normally the stone is free, and when there is sufficient urine to surround it, the stone, being heavier, sinks to the lowest part of the bladder. As the patient is usually examined lying down, the stone is felt in the fundus. If, however, the bladder contains only a small quantity of urine the stone may be grasped by the contracted upper part of the bladder and held there while urine collects in the part below, that is, the fundus and neck, where search is generally made with the sound. This is particularly apt to

occur in children with a relatively large stone, and the writer has several times seen such cases sounded repeatedly with negative result, when a simple bimanual examination at once disclosed the presence of a large stone. If in such a case the sound is passed an inch or two further into the bladder and directed towards its apex, the stone is at once felt. The greatest cause of difficulty in detecting a stone is usually met with in adults and most often in elderly men with enlargement of the prostate. The latter condition may of itself impose an insuperable obstacle to the introduction and manipulation of the sound, though this is rarely the case if skill is used. The stone or stones may lie in a deep pouch or recess, either that which is always formed behind and below the projecting prostate itself, or in an actual hernial protrusion of the bladder mucous membrane which may be formed in any part between the hypertrophied muscular fasciculi. Such a pouch or diverticulum may reach a large size, and may communicate with the general bladder cavity by a quite narrow neck, and it is obvious that it may be quite impossible to reach with the sound a stone lying in it. When the stone lies in the post-prostate pouch it may sometimes be felt by turning the sound completely round, so that the beak points directly backwards, and at the same time the base of the bladder may be pushed up by a finger in the rectum. Another method is to distend the bladder moderately and then place the patient in a position with the pelvis raised considerably above the level of the shoulders. If the stone is free in the bladder it will be felt towards the apex of the bladder, which is now the lowest point.

Although for rapid and summary diagnosis the sound is still an indispensable instrument, we have in the modern cystoscope a means of directly inspecting the interior of the bladder, which while no more difficult to introduce than the

sound, is capable of ascertaining at the same time, not only the presence or absence of stone, but many other facts equally important. Although this instrument was practically perfected in 1886 and has been regularly used ever since by specialists in urinary surgery, its value and importance are still imperfectly appreciated by general surgeons. It is not too much to say that it is impossible to complete the diagnosis of a large number of urinary cases without it, and that every surgeon ought to famaliarize himself with its use. That many have neglected to do so is due first to an imperfect appreciation of the clearness of the view which can be obtained of the inside of the bladder by its means, and secondly to an exaggerated idea of its technical difficulties. It is not, as a matter of fact, a difficult instrument to use, and although practice and familiarity are required in recognizing and interpreting the facts which it reveals, they are not more difficult to acquire than they are in the use of other clinical instruments such as the ophthalmoscope or the laryngoscope. No attempt will be made here to give an exhaustive account of the construction and use of the cystoscope, which will be found in special treatises devoted to the subject; but a few hints will be given first as to the manner in which any surgeon may master its use, and afterwards the principal diagnostic problems it enables us to solve will be discussed and illustrated. The cystoscope consists essentially of a small lamp which lights up the interior of the bladder and a telescope by which the various parts of it can be inspected; the two being combined and contained in a single instrument, having somewhat the form and size of an ordinary bladder sound, with a short, straight beak. The shaft is cylindrical, with a length of about 12 inches and a diameter of about $\frac{1}{4}$ inch. The beak is of the same diameter as the shaft, and makes an obtuse bend with it. Its

rounded extremity is formed by a metal cap, which holds within it the little electric lamp. The shaft, which is hollow, contains an eye-piece at the end of the shaft, and an object glass at the termination of the straight portion. The rays of light proceeding from the interior of the bladder when illuminated by the lamp are received by a small window in the shaft, at its junction with the beak, and on the same aspect or surface as the lamp. The window is formed by a glass prism, by means of which the rays of light are refracted and made parallel with the shaft, and carried through the various lenses of the telescope to

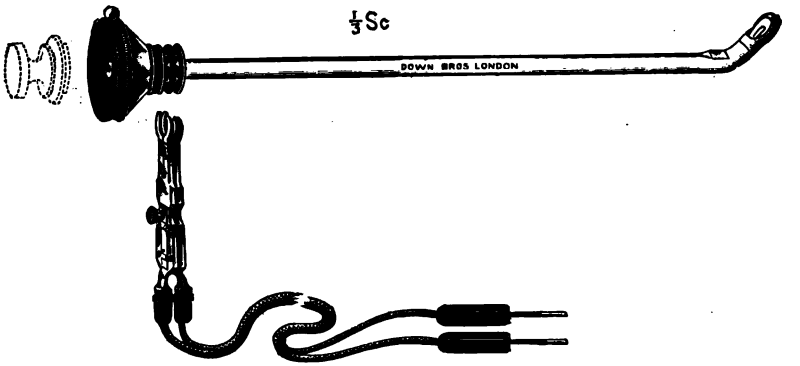


FIG. 2.--Nitze's Cystoscope.

the eye of the observer. In another form of the instrument the window is placed on the convexity of the "elbow" or angle, where the shaft joins the beak. In this form there is a straight line for the light rays from the eye-piece to the bladder, and, therefore, no prism is required, the window being closed with plain glass. This form was designed in order to obtain a view of the posterior and inferior aspect of the bladder, but since the length of the beak has been reduced to its present dimensions there is no difficulty in rotating the cystoscope through a complete

circle, and thus bringing any part of the bladder opposite the window. It is not, therefore, necessary to make use of two forms of cystoscope, and that with the prismatic window in the concavity is the more convenient and useful form for all purposes.

The cords by which the electric current is conducted to the cystoscope lamp join the shaft at right angles just below the eye-piece by means of a metal plate, which grips the shaft and makes contact with it, but permits it to be rotated in any direction without twisting the cords. This plate, which serves also as a handle, bears a switch, by means of which the current can be turned off and on at will. The current may be taken from a switchboard connected with the electric main, or from a primary or secondary battery. Where there exist facilities for charging a secondary battery the latter is far more convenient than a primary battery, which is less portable owing to its greater size and the liability of the battery fluid to be upset.

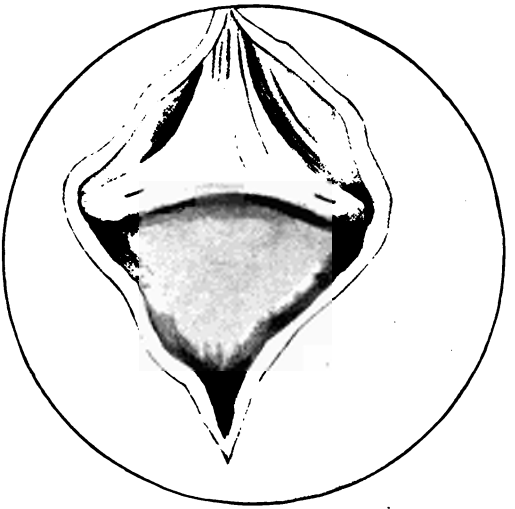
A good cystoscope and secondary battery can be purchased for from £8 to £10, together with a supply of spare lamps. The best form of lamp is that known as the "cold lamp," which can be kept lighted in the open air without becoming hotter than can be borne by the finger, and which, therefore, incurs no risk of burning the bladder. The exact strength of current required varies with each lamp, and therefore it is necessary to have a small variable resistance or rheostat, by which the current is regulated. The resistance is gradually diminished until the lamp glows with a steady white light, and the incandescent fibre within the globe cannot be distinctly seen. If too strong a current is used the fibre may be fused and the lamp spoilt.

In order to learn to use the cystoscope the surgeon should first thoroughly familiarize himself with the different parts of the instrument and with the battery. If, when

all the connections are made and the switch turned on, the lamp fails to light, or lights insufficiently, there is some defect either in the lamp itself, in the connections, or in the battery. If due to a defective lamp a new one should be screwed on and tried. If this fails search must be made with the various connections. It may be due to (1) that which connects the lamp with the cystoscope, a small wire spring, which may require cleaning or adjusting; (2) to the connection of the cords with the handle, or a breaking of the cord itself, generally near one of the terminals; (3) to a defect in the rheostat; (4) to the battery's being run down. A little investigation will soon reveal which of the defects is present and enable it to be remedied. It should be remembered that secondary batteries require to be periodically recharged whether used or not. Once a fortnight is a convenient period, but, in any case, it should not be allowed to go more than a month without being recharged.

After acquiring familiarity with the use of the battery and the mode of adjusting it, the next step is to practise with a model bladder. Such a model may be bought from the instrument maker, or it may be quite easily made out of an eight-ounce rubber bottle-syringe, such as is used for rectal injections, or an old Politzer's bag. The bone terminal may be replaced by a few inches of rubber tubing, of sufficient calibre to allow the passage of the cystoscope, and this will serve as a model of the urethra. If the end of the rubber tube is made to project into the bag it will serve to represent the projecting mouth of the prostate urethra within the bladder, and a notch cut in it will serve to mark its upper or lower side. The position of the ureters may be indicated by two pins, the points of which are made to transfix the rubber bag from without. Foreign bodies, such as buttons, small calculi, or similar bodies, can be introduced at pleasure. Letters stamped in

FIG. 3.—Normal trigone in Cadaver.



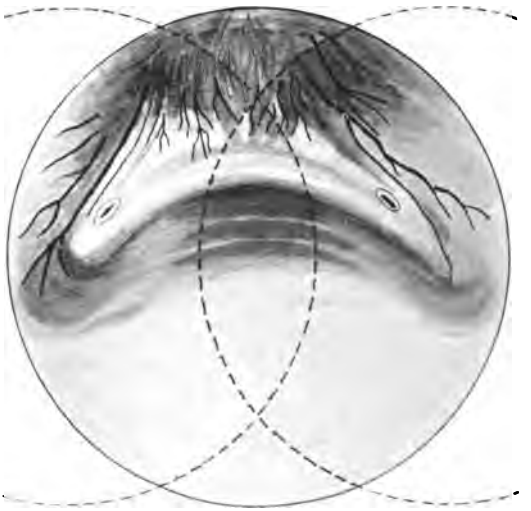


FIG. 4.—Normal trigone seen by Cystoscope.

relief on the inside of the bag, or the texture of the rubber itself, serve also as convenient objects to recognize with the cystoscope. If such a bag is filled with clear water and placed in a fixed position comparable to that of the bladder, every part of its interior can be inspected by the cystoscope with a clearness and precision which are surprising to the beginner.

As soon as practice and familiarity have been acquired by this means every opportunity should be taken of inspecting the normal bladder. For this purpose it is best to begin on anæsthetized patients. To the general surgeon with a hospital practice numerous opportunities will be found in the course of minor operations in the perineal region and neighbourhood, such as operations for piles, hernia, ruptured perineum, and the like. It is well to refresh the memory by studying the appearance of the interior of the bladder in the cadaver. When empty the mucous membrane of the bladder is thrown into small folds, and even when partly distended it presents a more or less reticulated appearance, being covered with small irregular depressions caused by interlacing bundles of muscular fibres which stand out beneath the mucous membrane. In cases of chronic obstruction from stricture or enlarged prostate this reticulated condition becomes much exaggerated, and some of the depressions between the fibres may become developed into saccules or diverticula; but even in the normal bladder it is generally visible. One portion of the bladder, however, always remains smooth—namely, the trigone, the triangular area between the mouths of the ureters and the internal orifice of the urethra. In this part the mucous membrane is firmly adherent to the muscular wall, and shows no folds except a few longitudinal pleats close to the urethra. Unless the bladder is fully distended the trigone is raised above the

rest of the mucous membrane, and its outline, therefore, well defined by its different level as well as by its smoothness and absence of reticulation. The posterior boundary or base of the trigone is slightly concave, the central portion of it being nearer the urethra than its extremities. It is formed by a band of muscular fibres which joins the ends of the two ureters, and forms a well-marked curved line termed "the interureteric bar." Each side of the trigone is similarly formed by a band of muscular fibres, which is prolonged from the ureter towards the orifice of the urethra. Each ureter lies, therefore, in an angle formed by the two bands, which diverge from it to form the boundaries of the trigone. The orifice of the ureter is a little slit about two millimetres in length, and is placed obliquely with its long axis pointing towards the urethra. In the cadaver it lies level with the surface of the trigone, but in the living body it may be either raised above it or depressed in an angular fold, according to the distension of the bladder and the activity or quiescence of the ureter.

The trigone and its neighbourhood are not only the most important landmark of the bladder, like the optic disk in the retina, but the seat of the commonest and most significant changes to be observed by the cystoscope; familiarity with its naked-eye appearances is therefore of the greatest possible assistance to the beginner in cystoscopy. Fig. 3 illustrates the points which have been described. Two points must be specially noticed. In the first place, a complete view, such as can be obtained by inspecting an open bladder, cannot be obtained in a single ocular field of the cystoscope, but must be pieced together from two or more fields. The circles in the illustration show approximately the area of a single field. In the second place, in the Nitze cystoscope, but not in some other patterns in common use, the image is inverted, so that the trigone is

viewed as if looking into the bladder from above. The internal orifice of the urethra, therefore, occupies the upper part of the field and the fundus of the bladder the lower part. As in the laryngoscope image, the right and left sides are not transposed. For the sake of comparison, the naked-eye view of the trigone shown in fig. 3 is placed in the position corresponding to the normal cystoscope view shown in fig. 4.

The conditions necessary for successful cystoscopy are that the cystoscope should be in perfect working order, that it can be introduced into the bladder, and that the latter contains a sufficient quantity of perfectly clear fluid. The instrument must therefore be tested immediately before its introduction, and the patency of the urethra proved. Stricture of the urethra is, of course, a complete bar to cystoscopy until it has been either divided or dilated. The majority of cases of enlarged prostate present no insuperable obstacle to the introduction of the cystoscope if the shaft is well depressed and the beak afterwards thrust well into the bladder until it can be rotated freely in all directions. Large growths occupying a considerable part of the bladder-space renders cystoscopy difficult or impossible, as the lamp becomes embedded in its folds and the light is obscured or extinguished. The bladder must be able to hold not less than four ounces of fluid in order to give sufficient play and space. In certain cases of ulceration, or chronic cystitis, the bladder may be chronically contracted and unable to hold the requisite quantity of fluid. In other cases the bladder may be so intolerant of distension that it contracts and expels the fluid as soon as it is introduced. This difficulty can usually be overcome by injecting a drachm of 10 per cent. solution of cocaine or a larger quantity of eucaine solution into the empty bladder, and after an interval of five minutes gradually distending

it to the necessary extent. Clearness of the medium is an absolutely essential condition for success, and more failures and disappointments are caused by neglect of this point than any other. When the urine is clear, and not too concentrated, it serves the purpose sufficiently well, and this condition can sometimes be secured by the previous administration of a diuretic and instructing the patient to hold his water for an hour beforehand. As a rule, however, it is better to trust to a colourless and perfectly clear solution of boric acid or normal saline introduced by catheter at the time of examination. Where the urine for any reason is turbid, it is necessary to wash out the bladder very thoroughly before introducing the artificial medium. When blood or pus is being constantly discharged into the bladder, it may be necessary to repeat the washing out several times during the progress of the examination. For this purpose some cystoscopes are made with a two-way channel, by means of which irrigation can be carried out without withdrawing the instrument. Others are made in which the optical portion, including the prismatic window, can be withdrawn from the hollow shaft, which then serves as a catheter. As a rule, it is better to wash out by means of a soft rubber catheter as often as necessary until the washings return perfectly clear. If the bladder itself contains the source of hæmorrhage, this can be temporarily arrested or reduced by injecting a solution of adrenalin chloride, 1 in 1000. Both cocaine and adrenalin have, however, the drawback of blanching the bladder mucous membrane, and should be avoided when it is desired to observe its natural appearance and colour.

The quantity of fluid used to distend the bladder is a matter of importance, since the cystoscopic appearances of the interior vary greatly with the amount of distension,

and one of the most important tasks of a beginner is to familiarize himself with these differences. No part of the bladder can be seen distinctly unless it can be brought within a certain distance of the window, a distance to be learnt by practice and experience alone. If the bladder is fully distended, certain parts of the upper and anterior walls cannot be brought near enough to be seen distinctly; on the other hand, the trigone and its neighbourhood are more clearly seen, because it is not obscured by overhanging folds of mucous membrane. The appearance of the orifices of the ureters varies greatly with the amount of bladder distension and still more with the angle at which they are viewed and their distance from the window of the cystoscope. They differ also from moment to moment while under observation according to the activity or quiescence of the peristalsis of the ureter itself. Lastly, the spurts or jets of urine which can be seen under favourable circumstances to issue from the ureters vary naturally, both normally and pathologically, according to the force and amount of the flow and the colour of the ejected fluid. All these require constant practice and observation, both of normal and abnormal conditions, before they can be detected and interpreted with certainty and correctness. Constant familiarity with the normal bladder under varying conditions is of particular importance, in order to control and check observations of abnormal appearances, and no opportunity of acquiring this familiarity should be neglected by the beginner. For beginners, especially for examination of the ureters, the patient should be under a general anæsthetic, by which straining and movements are minimized and much longer observations can be made without inconvenience to the patient. By practised observers and for more cursory examination cystoscopy can be applied without anæsthesia, or by using local anæsthetics

such as cocaine or eucaine applied to the bladder and deep urethra, but for difficult cases general anæsthesia is to be preferred.

Lastly, the remarks previously made as to the necessity of the most scrupulous asepsis in all instrumental examinations apply with especial force to the cystoscope. If the information obtained by means of its use is only obtained at the expense of septic infection, it may be purchased at a heavy or even fatal price to the patient.

The chief points in the appearance of the interior of the normal bladder when inspected in the cadaver by the naked eye have been described above. The appearance of the bladder seen in the living body through the cystoscope differs in several important respects. In the first place the living mucous membrane is of a semitranslucent and pale straw colour, and the delicate branching blood-vessels, full of blood, are plainly visible. The trigone is distinguished, not only by its smoothness and absence of reticulation, but by a deeper red colour, although this varies according to the amount of distension and the nearness or distance of the light. In order to inspect the trigone and the ureters the beak of the cystoscope is turned backwards or downwards (the patient is assumed to be in the lithotomy position) and the shaft depressed into a horizontal position. The instrument is then pushed gently inwards until the beak can be rotated freely without touching any part of the bladder, and then gradually withdrawn until the curved interureteric bar comes into view. Withdrawing it still more, the lower half of the internal orifice of the urethra (the mouth of the prostate in the male) comes into view as a sharply defined dark red crescentic fold contrasting with the light yellow of the rest of the ocular field. By rotating it now right and left the corresponding parts of the prostate and mouth of the

bladder come into view. When the prostate is enlarged and projects into the bladder the projecting portions can be seen as dark rounded lobes, sometimes translucent at their edges. The amount of the projection and the size of the lobes can be gauged by focussing them, *i.e.* by pressing in or withdrawing the cystoscope; but considerable practice is required to do this correctly, since the apparent size of all objects seen with the cystoscope varies with their difference from the window and the point of view from which they are seen. Their contour is more easily judged by gradually rotating the beak until it has traversed a complete circle, the position of the beak at any moment being indicated by a small knob on the ocular end. The difference of the internal orifice in the male and female, when there is no enlargement of the prostate, is less than might be expected. In both it presents a dark, sharply marked red ring, more or less notched by longitudinal pleats. In the middle line of the inferior half of the ring in the male, the uvula vesicæ, the normal representative of the so-called middle lobe of the enlarged prostate can sometimes, but not always, be seen as a little round eminence. Having inspected the internal orifice of the bladder, keeping the shaft of the cystoscope still in the horizontal position, the beak is thrust further in until the interureteric bar is again in focus. Then, by rotating the beak 45 degrees to the right or left, the corresponding ureter is brought into the centre of the field. It is seen generally as a little bright red slit lying just within the outer angle of the trigone, which is usually marked by a leash of vessels running along the raised fold which forms its outer margin. Other bundles of vessels are seen descending from the orifice of the urethra and diverging like the rays of a fan, as they proceed to the centre of the trigone. By altering the depth and angle of the cystoscope

the ureter can be examined from different points of view and its appearance and movements watched. If well focussed and watched steadily for some time at regular intervals, generally every fifteen or twenty seconds, but varying with the activity of the secretion (which is often considerably lessened during deep narcosis), the muscular bands surrounding the orifice will be seen to contract, and a moment later the orifice is relaxed and a little jet of urine escapes, forming a visible swirl or vortex in the previously quiet fluid contents of the bladder. The size and amount of movement caused by the jet vary of course with the amount of urine expelled from the ureter at its systole, but under normal conditions it is easily visible, and once seen can never be mistaken. When the fluid expelled consists largely of blood it forms a very striking sight, comparable to the sudden emission of black smoke from a chimney. Pus when thick or nearly pure, *i.e.* when admixed with little or no urine, is ejected from the ureter in an equally characteristic and striking manner, which has been aptly compared to the way in which a little coil of paint or ointment is squeezed from a collapsible tube. It falls in a little heap into the bladder immediately below the ureter and remains for a time, until it becomes mixed and diffused with the fluid. In order to make the normal ureteric jets more plainly visible the urine may be artificially coloured by administration of colouring matter, such as methylene blue, by the mouth a few hours before the examination; or by the hypodermic injection of a concentrated solution of indigo-carmine half an hour beforehand.

Bodies lying free in the bladder, such as calculi, naturally gravitate to the fundus, and by passing the cystoscope deeper into the bladder, they will be seen behind and below the interureteric bar, *i.e.* the base of the trigone.

When there exists a deep post-prostatic pouch, such as is generally formed in chronically distended bladders, obstructed by enlargement of the prostate, calculi may lie hidden within it, and it may not be possible to bring them into the cystoscopic field. The same difficulty may also be caused by deep pouches or diverticula in other parts. It is, however, seldom that either of these conditions is so marked as to prevent their recognition by the cystoscope. In ordinary cases nothing is more easily seen than a calculus, and the cystoscope has this additional advantage over the sound, that it enables multiple calculi to be recognized with equal ease.

After examining the trigone and fundus, every other part of the bladder should be inspected in turn, by rotating the beak and passing it towards each part in turn. The position of the apex is usually marked by a bright spherical body with well-defined outline, which moves with every movement of the bladder or shifting of the cystoscope. This body which sometimes puzzles beginners is merely a bubble of air, which seldom fails to enter during the process of washing out the bladder.

The diagnostic value of the cystoscope for all diseases of the bladder is self-evident. Practically every morbid condition discoverable by an operation or post-mortem examination of the bladder may be seen with equal or greater clearness through the cystoscope by any one who will acquire the necessary skill and practice. The value of the cystoscope as an aid to diagnosis of renal disease, though less obvious, is, if anything, still greater, since it often affords direct evidence in obscure cases, where it is most required. Symptoms not infrequently leave it in doubt whether a case is one of disease of the bladder or of one or both kidneys. Cystoscopic examination

enables us, not only to affirm or exclude any visible disease of the bladder, but often points definitely to one kidney as the probable origin of the symptoms, since when it is diseased the ureter in many cases participates in the process and the effects are visible in the bladder. Most forms of pyelitis, for example, tend after a time to spread downwards and affect the ureter, producing visible changes in its orifice, and even invading the adjacent mucous membrane of the bladder. Tubercular disease of the kidney generally affects the ureter at any early stage, and when it is at all advanced visible changes in the ureter and its neighbourhood may be nearly always seen by the cystoscope. On the other hand, inflammation may spread upwards from the bladder to the ureters and kidneys, and evidence of this process may be seen in one or both ureteral orifices, for the process is not always unilateral. It may be assumed that practically every gross lesion of the kidney, which affects the structure of the ureter, will display some corresponding change in the bladder orifice of the latter, as seen by the cystoscope; for example, greater or lessened patency, swelling and engorgement of its mucous membrane, hypertrophy of muscular bands or other changes. Other facts may be noticed of equal or even greater significance, viz. the character of the fluid expelled by the ureter, and the amount, force, and frequency of each jet. In all such observations careful comparison must be made between the two sides. The most significant and valuable are those which show clear and unmistakable deviations from the normal confined to one side. Apart from the localizing and diagnostic significance of seeing blood or pus expelled from one ureter, we have in cystoscopic observation of the ureteral jets a direct though imperfect means of judging the secretory activity of the kidneys. The presence of forcible and

copious jets of clear urine, at regular intervals of fifteen to twenty seconds, points to an active and healthy kidney. Irregular and feeble jets, or none at all, point to obstruction of the ureter or an inactive secretion. Secretory activity is influenced by so many causes, that allowance must be made for them in estimating the significance of cystoscopic observations; but when there is marked deviation from the normal on one side only its significance is considerable. As has been already pointed out, the previous administration of drugs which colour the urine facilitates these observations. The more the cystoscope is used not merely for exploring the bladder, but in order to inspect the mouths of the ureters and watch the urinary flow, the more will its value be appreciated in renal diagnosis and renal surgery.

The principal methods of physical examination of the urinary organs have now been fully described. There remains one other modern method of great value, namely radiography. The technical details of this method are beyond our scope. Few practising surgeons or physicians have the time or opportunities for acquiring sufficient skill in radiography to be of real service. In no method are there more pitfalls and fallacies for the inexperienced. It cannot be too strongly emphasized that the whole value of radiography in urinary diagnosis depends on the skill and experience with which it is applied and interpreted. For this reason the necessary examinations should always be left to expert radiographers.

The branch of urinary diagnosis in which radiography is of value is of course the detection and localization of calculi. When the calculus is large, and especially when it consists of the more opaque oxalates, its shadow is easily shown on the radiographic plate or screen. In such cases it is seldom of any great value, for the diagnosis is usually, though not

always, easy by other methods. Even in such cases it is useful to have the size and position of the stone demonstrated in a manner which will convince a possibly reluctant patient. It is, however, in the more obscure cases that radiography has its chief value, and in these the value of its evidence both positive and negative is in proportion to the skill and experience of the radiographer. Speaking generally, a failure to disclose any evidence of a calculus must be accepted with considerable reserve, and numerous exposures may be required in order to explore the whole urinary tract. When a well-marked shadow is shown in a position corresponding to any part of the urinary organs it may generally be accepted as conclusive of the presence of stone; but even this statement requires qualification, since similar shadows have been shown in the radiograph when subsequent operation has proved the absence of stone. In some cases, the shadows have been caused by calcified plates or nodules in adjacent arteries or glands; in others, the cause of the shadow has not been found. Apart from its value in confirming a diagnosis of suspected stone, there are two directions in which radiography is often of great assistance. In the first place there are many cases in which neither symptoms nor physical examination enable us to discriminate between stone in the kidney and stone in the ureter. It has been pointed out that it is only in the lower part of the ureter that calculi can be detected by these means. In this situation symptoms of renal pain and irritation are usually accompanied by painful micturition resembling the pain of stone in the bladder. When the calculus is not too minute it may also be felt per rectum or per vaginam, or, when it protrudes into the bladder, seen with the cystoscope. In the upper part of the ureter calculi can rarely be detected by palpation, and the symptoms do not clearly discriminate them from stone or other

causes of pain in the kidney itself. By introducing a sound or catheter into the ureter, it is true that an obstruction may be detected and the presence of calculus inferred, but the sound may be obstructed by a fold or kink in the ureter, so that this method is not only difficult but liable to fallacy. In such a case radiography is of the greatest value. Modern experience, both operative and radiographic, has, in fact, shown that calculi in the ureter, with or without other calculi in the kidney, are of very common occurrence; and there is no doubt that the negative result of many renal explorations for stone in the past, as well as many persistent urinary sinuses after nephrolithotomy, have been due to a failure to explore the ureter, as is now done by most surgeons as a matter of routine when operating on the kidney. The importance of a previous radiographic examination of the ureter as well as of the kidney is obvious. Lastly, when radiography is employed it should be the rule to examine the kidneys and ureters of both sides. In the first place it has been shown conclusively* that the symptoms of stone in one kidney may, although very rarely, be referred entirely to the opposite kidney, in which there is no stone. Most of the cases which have been published and explained in this way are no doubt open to great doubt, but in some the evidence admits of no other explanation. In the second place the presence of calculi on both sides is very common, even when the symptoms on one side are latent or absent. Such an occurrence it is obviously very important to know, and, if for this reason alone, a complete radiographic examination should be made whenever possible before operating for calculus.

* David Newman, in *Lancet*, April 23, 1904.

CHAPTER IV.

DIFFERENTIAL COLLECTION OF SPECIMENS OF URINE.

It has already been pointed out in discussing abnormal conditions of the urine that one of the first points to determine about any abnormal ingredient is the part of the urinary tract from which it is derived. In some cases this may be evident from the nature of the ingredients or from the symptoms associated with them; but evidence of this kind is not always present, and is rarely conclusive when it is. The origin of pus or blood in the urine, for example, in spite of the various clinical rules laid down for our guidance, is often impossible to determine without more direct evidence than that afforded by symptoms or by the character of the urine itself. In many cases the cystoscope discloses some visible source of blood or pus in the bladder itself, or enables us to see the actual escape of bloody or turbid urine from the ureter. There are, however, many cases where we require to collect the urine with its abnormal contents at the actual source of the latter, or as nearly as may be; and the methods by which this can be done will now be described.

For this purpose the urinary tract must be divided into its several parts. The first part consists of the anterior urethra—*i.e.* the first six inches, which lie in front of the constrictor urethræ. Blood or pus derived from this part, if in sufficient quantity, is discharged from it by gravitation

independently of micturition—for example, the blood from a urethral laceration or the pus of an ordinary gonorrhea. If the quantity is too minute to be recognized in this way, it may be found by washing out the anterior urethra with some neutral fluid, and examining the washings with the microscope. This may be easily done by injecting the fluid gently with an ordinary urethral syringe, and then collecting it as it escapes from the meatus when the syringe is removed. Injected in this way, the fluid is prevented from entering the deep urethra by the constrictor urethræ, or, as it is sometimes termed, the anterior sphincter, which is sufficiently powerful to resist considerable pressure from the side of the meatus.

The contents of the deep urethra—*i.e.* the membranous and prostatic portions on the proximal side of the constrictor—can be obtained for microscopic examination, by collecting in a test-tube the first two drachms of urine which a patient passes, after washing out and cleansing the anterior urethra in the manner described. This method is, of course, open to the objection that any abnormal material such as pus or blood, which it may contain, may have been derived from the bladder and not from the urethra. If, however, after collecting the first two drachms in a test-tube the remainder of the urine is passed in another vessel and is found free from pus or blood, or contains them in a very much smaller quantity, it may be assumed that they proceed from the urethra. This simple procedure, which is termed the "two-glass test," although it is free from fallacy, since blood or pus derived from the bladder may gravitate to its lowest part and escape with the first discharge of urine, is of considerable value, and should always be applied if there is any possibility of urethral mischief. Neglect of this precaution has often caused pus in the urine to be attributed to cystitis or pyelitis when

really due to gonorrhea. The examination of the first few drops of urine passed by a patient in the morning on rising is also a convenient way of ascertaining the progress of treatment in cases of gonorrhea. Pus will often be found in this way long after all visible discharge has ceased from the meatus, and it may then contain the characteristic "threads" and "banners" derived from a chronic granular patch in the deep urethra. In such a case the ordinary anterior injections are useless, since they never reach the affected part, and the deep urethra must be treated directly, either by deep injections through a catheter, or by applications made through the urethral speculum.

The next portion of the urinary tract, the bladder, contains, of course, the mixed urines of the two kidneys, and any abnormal bodies derived from them or from the ureters may be mingled with similar or different bodies derived from the bladder. Urethral products may be excluded by rejecting the first portion of urine passed, or by drawing off the urine with a catheter—a precaution often necessary in the female to avoid chance contamination from the external genitals. In order to distinguish between bladder products and renal products, the bladder may be first thoroughly washed out until the washings return quite clear, and the catheter being left in for five or ten minutes, the urine which drips from it is collected and examined. This, of course, forms an approximation to collecting urine directly from the ureters, with possible contamination from the bladder, reduced to a minimum. Although the method is simple and may in some cases be of value, it cannot be relied on, and is not free from the risk of sepsis, owing to the amount of manipulation required. It is, moreover, superseded by more exact methods.

In order to ascertain with certainty the source of any abnormal body in the urine, it is necessary to have a

reliable clinical method of collecting the secretion of each kidney separately, and of preventing at the same time any admixture of pathological products from the bladder. It is obvious that such a method has also the advantage of permitting a direct estimation of the secretory activity of each kidney—a matter of fundamental importance for many purposes. The most obvious means of achieving this result is to catheterize the ureters. In the female, various methods of passing catheters into the ureter by direct touch or sight have been devised and practised with more or less success; but all of them are unreliable except that of Kelly, by which the urethra is dilated, the bladder filled with air, and the orifice of the urethra directly exposed through a cylindrical speculum. The use of a special cystoscope, by which a catheter can be brought into the visual field and guided into the ureteral orifice, is, however, to be preferred to the method of Kelly, since, while no more difficult to apply, it is equally applicable to male and female. Catheterizing the ureters is now frequently employed by skilled cystoscopists, and, given the necessary practice and skill, it is the most certain, direct, and simple means of separating the two urines which can be devised for clinical purposes. The operation is, however, decidedly difficult, and not free from the danger of infecting the kidneys.

In order to avoid the difficulties and dangers inseparable from the introduction of catheters into the ureters, several instruments have been devised for artificially dividing the bladder and urethra into two channels, by which the two urines are prevented from mingling, and are discharged separately. These instruments are named urine separators or segregators.

The earlier instruments of Neumann and Harris, based on this principle, although they achieved their aim in many cases, were uncertain in their results and open to many

fallacies. At present we possess two instruments, those of Luys and Cathelin, which are not only simple and easy in their application, but which have been tested and proved to be efficient by numerous clinical workers. Both instruments consist essentially of a double catheter, from which, after it has been passed into the bladder, a vertical membrane or curtain is protruded or raised, which divides the bladder into right and left watertight chambers. The urine from each ureter collects in its corresponding chamber and is thence drawn off by a separate catheter. In Cathelin's instrument, which has the form of an ordinary sound, the dividing membrane of thin rubber is carried on a loop of thin steel which lies within the hollow shaft until the instrument has been introduced and placed in position in the bladder. The loop is then made to protrude through a slit in the convex side, and as it does so it assumes a circular outline which accommodates itself to the bladder in the median antero-posterior plane, and extends the rubber membrane which is attached to it.

In Luys' instrument the terminal curve is specially designed to fit the floor of the bladder closely and accurately when placed in position. It is an almost semicircular arc of about three inches long, and the shaft joins it at an angle, like the handle of a soup-ladle with its bowl. This angle, which is an essential feature of the instrument, lies just at the internal orifice of the urethra when the instrument is in position, so that the curved portion is within the bladder. The separator, which at first glance looks like a full-sized silver catheter with a peculiar curve, consists of two separate catheters fitting closely to a flat central stem which projects slightly on the convexity of the curve. The catheters are held in position by sockets in the handle, and by a screw cap at the free end. The outer end of each catheter is bent downwards, so as to drip

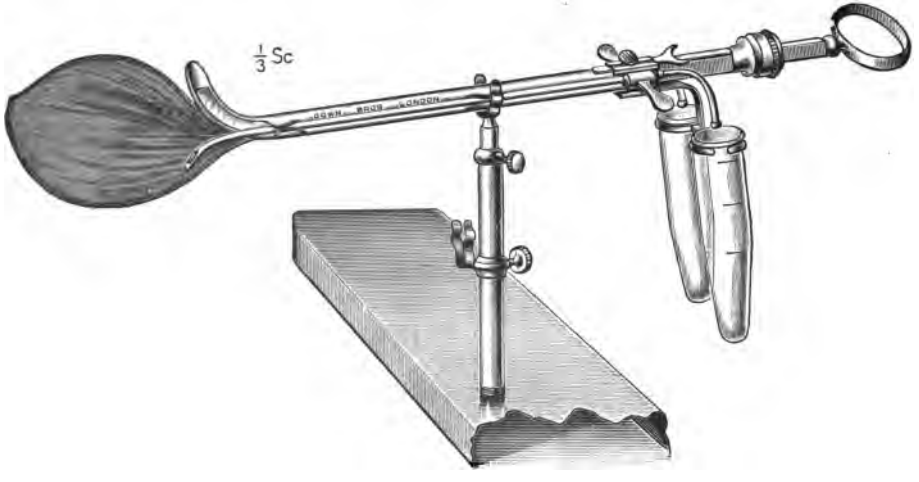


FIG. 5.—Cathelin's Separator.

into a glass tube held beneath it by a detachable carrier. The bladder-ends have several large eyes for the admission of urine. After unscrewing the terminal cap the catheters can be slipped out of the handle. The flat central stem of the instrument is then disclosed, having of course the same curve as the catheters. It is invested with a thin rubber tube or sheath which is concealed from view by the catheters when these are in position. Inside the sheath and fixed to the top of the curve is a fine chain, which

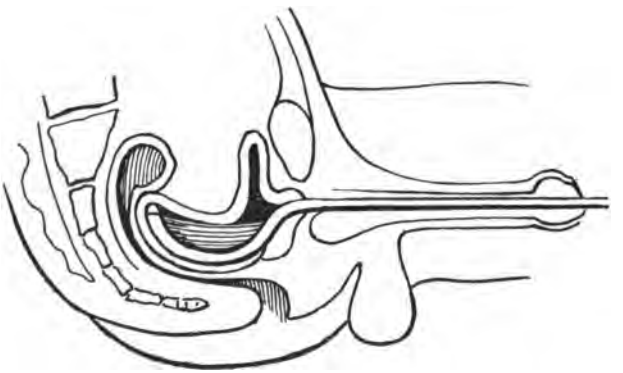


FIG. 6.—Luys' Separator in Position.

can be tightened by turning a screw at the end of the handle. The effect of tightening the chain is to bring it into the position of a bowstring joining the ends of the arc, and at the same time to expand the rubber sheath into a crescent-shaped vertical septum, which effectually divides the lower part of the bladder into two chambers, right and left. When the shaft is depressed slightly below the horizontal, urine discharges itself drop by drop from each catheter separately.

As regards the design of these two instruments, though both are ingenious, that of Luys is, in the writer's opinion,

FIG. 7.—Luys' Separator.

to be preferred. The septum of Cathelin might be thought to fit the bladder more accurately than the curve of Luys' instrument, owing to the flexibility of the spring which forms the outline; but the spring is too weak to press firmly against the bladder-wall, and at the same time fully distend the membrane. On the other hand, it is obviously more liable to deviate from the vertical plane without being detected—a circumstance which might completely vitiate the observations. In Luys' instrument the plane of the septum can only move with the whole instrument, and can be kept in its proper position without difficulty. The fact that Cathelin's septum can be varied in size at will, in order to fit bladders of different size or distensibility, has been held to constitute a superiority. In adult bladders, however, the measurements of the trigone are practically constant, and Luys' instrument is based on this fact, the length of its curve being such that its centre when in position lies on the line joining the two ureters. It may be objected to Luys' instrument that the septum is incomplete above, and that admixture of the two urines is possible over its upper border. So long as there is a free passage for the urine along the catheters, and the extremities are held below the level of the top of the septum, such admixture is impossible, and the complete septum of Cathelin has no practical superiority on this ground.

Whatever may be the ultimate verdict as to the relative merits of these two instruments, the writer has satisfied himself, by frequent and constant use, that the separator of Luys fulfils all the claims made for it by its author, and that it provides a means of separating the two urines, so exact, so simple, and so easily applied, that it leaves very little to be desired. It is used as follows: The patient should, if possible, be prepared beforehand by the administration of an aperient, followed by an enema, and should

drink a large cup of tea or coffee a quarter of an hour before the operation in order to ensure a free flow of urine. It is useful also in many cases to administer some colouring agent, such as methylene blue or indigo-carmine, either subcutaneously or in form of pill. A subcutaneous injection of 1 c.c. of 5 per cent. sterilized solution of methylene blue may be given two hours before the operation, if preferred. If given by the mouth, in the form of a five-grain pill of the same substance, an interval of four to six hours is required. The advantage of this procedure is that the dye is excreted more rapidly by a healthy than by a diseased kidney, and consequently a significant difference may be noted in the tint of the two urines. The usual precautions for securing asepsis must be scrupulously observed. When the urine is being collected the patient must be placed in a sitting posture, since the security of the division between the two parts of the bladder and the validity of the whole operation depends upon it. For this reason complete anæsthesia is inadmissible, since it cannot be induced safely in the sitting position. When the patient is unable to bear the small amount of necessary pain and inconvenience, a general anæsthetic, preferably ether, may be administered to a sufficient degree to partly dull the consciousness while the instrument is being introduced, and discontinued afterwards. But it is better, if possible, to dispense entirely with general anæsthetics as, apart from the risk, they often diminish or inhibit the secretion of urine. During the preliminary procedures, and while the instrument is being introduced, the patient should rest either on the end of a horizontal table with the legs apart, and supported separately, or in the lithotomy position, which is generally more convenient. When the separator is in place, the feet must be lowered and placed on special foot-rests, or on separate stools of convenient height. The

back and head are then raised nearly into the vertical position and supported by a back-rest, so that the patient rests comfortably against it without any muscular strain.

In order to prepare the separator for use, the catheters are detached from the stem, and the rubber sheath slipped over the latter. New sheaths being coated within and without with talc powder slip easily over the dry stem, but a sheath which has been rendered damp by previous use or by boiling, is most easily slipped on by filling it first with glycerine. The sheath should next be stretched by tightening the chain, and inspected to see that it is free from holes. It is then carefully washed with a solution of lysol. The whole instrument when fitted together may be boiled for a few minutes in plain water, or the metal parts of the instrument may be boiled separately from the sheath to prevent the tarnishing effect of the rubber when boiled with the metal. After being used a few times it usually becomes too loose, and must be replaced by a new one. When the parts have been fitted together the chain should be tested again, and the patency of all the catheter-eyes verified.

It is obvious that in order to obtain the secretions of the kidneys in a pure state, there must be no source of contamination in the bladder. If there exists in the bladder or urethra any ulcer, growth, or bleeding point from which blood or pus may mingle with the urine on either or both sides of the septum, the observation is necessarily vitiated. Consequently it is necessary either to make sure that the bladder is healthy, or to wash it out thoroughly first, and if necessary to arrest or prevent hæmorrhage by an injection of adrenalin solution. Great care must also be taken to avoid causing hæmorrhage by rough manipulation when introducing the instrument. For these reasons it is a good plan to begin by washing out the bladder through a soft

catheter, and then to anæsthetize the deep urethra and bladder by injecting a solution of 5 to 10 per cent. cocaine, which is left *in situ* for five minutes. If there is any tendency to hæmorrhage adrenalin solution should also be used. It is then easy by a rapid cystoscopic examination to exclude any condition within the bladder which is capable of complicating the use of the separator. When the urine is clear, and bladder symptoms are absent, the cystoscope may be dispensed with.

Having these preliminary procedures proved, that the bladder will hold not less than 6 ounces of fluid, and that the urethra permits the passage of a full-sized instrument, the separator may be introduced. The patient being still in the lithotomy position, and the bladder filled with 6 to 8 ounces of fluid, the instrument, well lubricated with boroglyceride, is passed like an ordinary silver catheter until the point just enters the bladder. The handle is then depressed 45 degrees or more below the horizontal, and at the same time thrust steadily onwards and upwards, until the whole of the curved portion is felt to slip within the bladder. In the female this presents no difficulty. In the male a little practice is required in order to do it with ease and certainty. If the method described is not successful, the handle may be rotated a quarter of a circle to the right, at the same time as it is depressed below the horizontal. When in its proper position the whole of the convex portion of the curve lies within the bladder in its median antero-posterior plane, with the angle resting on the internal orifice of the urethra (see figure), and the convexity of the curve fitting closely to the base of the bladder. This can be easily verified by rectal or vaginal touch. The projection of the central stem beyond the convexity which has been pointed out is in order to ensure a closer fitting of this part to the bladder-floor. As soon as

the instrument is within the bladder the fluid should escape from the catheters freely and with equal force. Should it be observed to escape from one only, it may be due to the partial exclusion of one or two eyes by a fold of a too large rubber sheath. If so, it will be remedied by a slight tightening of the chain. If any doubt exists as to the equal patency of the two catheters fluid should be injected into the bladder through one catheter, while the other is first closed with the finger and then allowed to escape. The same manœuvre may be adopted if the escaping fluid is tinged with blood, caused by the passage of the instrument. It is essential that the complete patency of the catheters should be established before going further, in order to avoid an obvious fallacy. The next step is to tighten up the chain to the full extent, and to hold the instrument in its correct position. The tightening of the chain, if the separator is fully passed, causes no pain or difficulty. If either occurs, the part of the curve may be inferred to be within the urethra, and the chain must be relaxed and the position rectified before proceeding. The patient must now be raised into the sitting posture already described, and the separator adjusted so that it lies accurately in the median sagittal plane. In order to keep all parts of the curve in contact with the bladder-floor the handle must be raised to just below the horizontal and pulled gently forwards. After the escape of the fluid injected into the bladder a pause occurs, during which nothing is discharged from the catheters, although the bladder is not completely emptied, since a small quantity of fluid remains in each chamber below the level of the outlets. As soon as sufficient urine has entered from the ureters to raise the fluid to the necessary level, the flow begins again. *Since, however, the urine enters the bladder drop-wise from the ureter, and since each drop displaces*

an equivalent quantity of fluid from the catheter, the periodicity and rhythm of the contractions of each ureter are reproduced at the end of the corresponding catheter, a circumstance which adds greatly to the diagnostic value of the separator. It follows, of course, that the drops at first discharged from the catheter consist merely of the injected fluid, and not until this has been expelled can pure urine be collected in the tubes.

In normal patients the following facts will be observed: At regular intervals of fifteen to thirty seconds two or three drops will be seen to fall from the end of each catheter in rapid succession. The size and number of the drops at each ejaculation and the length of the intervening pause depend on the activity of the secretion and on the patency and force of the water, since each group of drops represents a single jet expelled from the latter. Naturally the rate of flow varies with all circumstances which influence renal secretion, but in a case prepared in the ordinary manner by drinking a cup of tea or copious draught of water, 10 cubic centimetres of urine will generally be collected in ten minutes or less. Under other circumstances half an hour or more may be required to collect the same quantity. The escape of drops is not simultaneous from the two catheters, and even from healthy kidneys the rate of flow is seldom quite identical. Careful examination has shown that even in health the specimens of urine collected from the two kidneys display slight variations in chemical composition, colour and specific gravity.

The value of any form of urine separator depends of course on its efficiency and reliability. Any surgeon who desires to satisfy himself that Luys' instrument really effects what it claims to can easily repeat his experiments on the cadaver in which fluid is injected into each ureter in turn while the separator is in position in the bladder. In

this way it is shown that in the horizontal position of the body fluids injected through the ureters mingle in the bladder by passing behind the curve of the separator where it fails to fit quite closely. When the body is placed in a sitting posture with the trunk inclined forward and bent, a similar escape from one chamber of the bladder to the other is found to take place in front, above the upper border of the septum. In the intermediate position between these two, that is in the ordinary sitting posture with the trunk rather less than vertical, the separation is found to be perfect, so long as quantities of fluid not exceeding 2 c.c. are injected into the ureter at one time. When sufficient fluid is injected to more than fill the corresponding chambers of the bladder the excess escapes into the other chamber invariably over the upper border of the septum; the bottom of the latter fits closely and is quite watertight, so that fluid injected into one ureter in quantity not exceeding 2 c.c. is discharged entirely by the corresponding catheter, and the opposite bladder-chamber remains dry. Or again, coloured and colourless fluids injected simultaneously into the two ureters are discharged from the corresponding catheters without admixture.

A similar experiment to the latter may be easily tried on the living by injecting a sterilized coloured solution, such as methylene blue, into one chamber through the catheter. So long as the quantity injected does not exceed 2 c.c. no trace of colour will be found in the fluid from the opposite catheter. Since each catheter is capable of holding only 1 c.c. of fluid, this fact cannot be explained, as has been suggested, by the coloured fluid remaining in the catheter and not entering the bladder.

Apart from the above experiments, which are easily verified, clinical experience will soon convince any impartial observer that Luys' separator does effectually separate.

This is shown most convincingly when the instrument is applied to a patient from whom one kidney has been removed. Urine flows entirely from that catheter which corresponds to the remaining kidney. In numerous other cases the differential result is hardly less striking; for example, quite bloody urine may be collected in one tube while in the other may be pale normal urine. Or one tube may be rapidly filled with normal urine while the other remains empty or contains a few colourless drops. If methylene blue is administered beforehand the result may be even more striking, for the secretion of the normal kidney will be of a deep blue colour, while that from the abnormal kidney may contain scarcely a trace of blue coloration. Such observations, which are frequent and typical, will serve to convince the most sceptical of the efficiency of the separation.

The chief facts to be noted when making a separation of the urines are the amount of urine collected in a given time, the mode of ejaculation, the colour, the amount of urea, and the nature of the visible contents in each specimen, including the microscopic appearances. A marked difference in any or all of these respects between the two sides is always significant. When a considerable difference is found in the amount collected, the abnormality may be assumed to be on the side which is deficient, and not on that which is in excess. It may be due to deficient renal secretion or to obstruction of the ureter; when the latter is due to some chronic cause, secretion is generally also diminished or arrested.

The mode of ejaculation is important. Regular rhythmic ejaculations may be taken to indicate that the kidney, even if not sound, is capable of vigorous secretion; when its activity is seriously affected the drops fall slowly and uniformly, and not in rhythmic groups. If nothing escapes

from only one catheter the cause may be assumed to be obstruction, since complete arrest of secretion without obstruction is always bilateral. Obstructions of the ureter by calculi, pus, or cheesy tubercular matter are the commonest causes of unilateral obstruction. Kinking or torsion of the ureter in cases of hydronephrosis may also give the same result. Sometimes the obstruction may be temporarily overcome during the separation by manual compression of the affected kidney, and will be followed by the sudden escape of turbid fluid or pus from the corresponding catheter. The colour of the fluids in the two tubes, apart from the presence of blood or pus, may be taken as a rough indication of the amount of urine present in each, the side of deficiency being the abnormal. This is usually confirmed by finding a deficiency or absence of urea in the pale or colourless tube. The use of methylene blue given previously by mouth or hypodermically affords a valuable corroboration, since the rapidity with which the pigment is excreted is a good test of the activity of the renal function, as has already been mentioned, and the side of deficiency is shown by the smallness or absence of blue coloration of the fluid in the corresponding tube.

The microscopic contents are of decisive significance only when a marked difference exists in the two specimens. If blood or pus, even in small quantity, are found on one side and are absent on the other, the fact is generally significant; but the finding of a few blood-cells in both tubes is of no value, since they may be due to a slight hæmorrhage caused by the introduction of the separator. Even blood in a single tube may occasionally be due to the same cause when it happens to trickle from the internal urethral orifice, or a small vessel on the prostate into only one of the two chambers of the divided bladder. Any doubt

on this point can be set at rest by thoroughly washing out the bladder through each catheter in turn, and, if necessary, instilling a drachm of adrenalin solution. Pus, even in microscopic quantity, if confined to one side, and in the absence of cystitis, may be taken as derived from the corresponding kidney or ureter; but when any source of pus exists in the bladder or prostate, no amount of preliminary washing out will exclude the possibility of microscopic traces of it n one or both tubes. Speaking generally, minute quantities of blood or pus are not to be relied on, unless they are absolutely confined to one tube and the bladder is known to be healthy. It might be thought that this fact would detract considerably from the value of the separator, but as a matter of clinical experience, when a differential result is obtained at all, the difference is well marked and unmistakable. The microscopic differences are less important than the differences in the amount of urine collected from each side, the manner in which the drops escape, and the colour and amount of urea in the two specimens. When a positive difference is obtained by the separator, it is nearly always a difference in all these respects, and not merely in the presence or absence of microscopic traces of blood or pus.

Even a negative result of the separation—that is, a result which discloses no material difference in the two specimens, or their mode of ejaculation—has considerable value. If the drops fall from each catheter in regular rhythm, and at the usual rate under similar circumstances, and if the amount of urea in each is similar, it may be accepted as good evidence that the patient has two kidneys which, even if not free from disease, are both functionally active. If methylene blue has been administered, and both specimens are brightly and equally coloured, the evidence of the essential functional soundness of both kidneys is con-

siderably strengthened. It is true that this statement does not cover the whole ground, since there may exist in one kidney a lesion which does not perceptibly impair its powers of secretion, or alter constantly the character of the urine. A stone, for example, without obstructing the ureter, or always causing hæmaturia, may yet give rise from time to time to pain or other symptoms for which the patient may seek advice. In such a case it is a matter of chance whether the separation of the urine would or would not disclose any difference. Unless the urine chanced to contain blood at the time of the separation, the result would be absolutely negative. There are many cases of intermittent bleeding from the kidney in which the same negative result would be obtained by the separator unless an opportunity was presented of using it at a time when hæmaturia was still present. Cases in which a renal mischief on one side is suspected from the position and character of the pain, and without any abnormality being found in the urine, are very common, and the writer has often used the separator with the hope of clearing up the diagnosis. In a few cases the suspicion was confirmed by obtaining a positive differential result. In many others the result was negative. In a few of the latter, the persistence and troublesomeness of the pain were such that the kidney was explored, but nothing abnormal was found. Although therefore it must be admitted that a normal result from separation does not positively exclude all unilateral diseases of the kidney, it does probably exclude the majority of them; and when the evidence of the separator is negative, very strong evidence of other kinds is required to justify an acting diagnosis in spite of it. *If any marked deviation from the normal is present in the urine of either kidney or of both the separator will certainly show it; more than that cannot be expected.*

The value of the separation of the urines is not confined to helping to locate the affected kidney. It goes a long way towards answering the important question, Is the other kidney sound enough to justify the removal of that which is principally diseased? The methods by which the combined functional capacity of the two kidneys may be estimated with more or less precision, from observations of the combined urines and of the blood, have already been described (see page 36). Whatever value these methods have, is increased when they are applied to the separated urines. Moreover, methods based on the combined urines merely indicate the total renal capacity, and are incapable of indicating how much of this is due to the supposed diseased or the supposed healthy kidney. If the clinical signs of disease on one side are obvious, it may be inferred that the other kidney is doing the bulk of the work, and that therefore the diseased kidney may be safely removed. The inference is obviously by no means certain, and the underestimating of the activity of the diseased kidney or the overestimating of that of the supposed healthy—a mere guess in any case—may be responsible for a fatal nephrectomy.

The separator, on the other hand, enables us to estimate the functional capacity of each kidney with an accuracy sufficient for most practical purposes. The quantity of urine secreted by each kidney in a given time varies of course greatly according to temporary circumstances, apart from disease, such as the temperature of the room, the amount of perspiration and transpiration, and the amount and quality of fluids recently ingested. The quantity collected in each tube of the separator in a short space of time cannot therefore be taken as an index of functional capacity without qualification. For the purpose of an accurate quantitative estimation a period of at least twenty-

REFERENCES.

LUYS: "La Séparation de l'Urine des deux Reins." Paris, Masson et Cie., 1904.

THOMPSON WALKER: "The Estimation of the Functional Value of the Kidneys." *Practitioner*, September 1906. "Renal Function in its relation to Surgery." Hunterian Lectures, 1907.

CASPER AND RICHTER: "The Diagnosis of Kidney Disease." Rebman, Ltd., London, 1903.

HURRY FENWICK: "Ureteric Meatoscopy in Obscure Diseases of the Kidney." Churchill, 1903.

DAVID NEWMAN: "Demonstrations on the Cystoscope." *Brit. Med. Journ.*, March 1906.

SELECTED LIST
OF
NEW AND RECENT WORKS
PUBLISHED BY
H. K. LEWIS,
136 GOWER STREET, LONDON, W.C.

(ESTABLISHED 1844).

TELEGRAMS: Publicavit, London.

TELEPHONE: 10721 Central.

*** *For full list of works in Medicine and Surgery published by H. K. Lewis see complete Catalogue sent post free on application.*

FREDERICK T. ROBERTS, M.D., B.SC., F.R.C.P.,
Emeritus Professor of Medicine and Clinical Medicine in University College; Consulting Physician to University College Hospital, &c.

THE THEORY AND PRACTICE OF MEDICINE. Tenth Edition, 2 vols., with Illustrations, lge. 8vo, 26s. *nett.*

H. LEWIS JONES, M.A., M.D.
Medical Officer in charge of the Electrical Department in St. Bartholomew's Hospital; late President of the British Electro-Therapeutic Society, &c.

MEDICAL ELECTRICITY; a Practical Handbook for Students and Practitioners. Fifth Edition, with 12 Plates and 187 illustrations, demy 8vo, 12s. 6d. net. [*Just published.*

[LEWIS'S PRACTICAL SERIES.

HENRY R. SWANZY, A.M., M.B., P.R.C.S.I.
Surgeon to the Royal Victoria Eye and Ear Hospital, and Ophthalmic Surgeon to the Adelaide Hospital, Dublin.

AND

LOUIS WERNER, F.R.C.S.I., M.B., B.CH. DUB.
Ophthalmic Surgeon, Mater Miser Hospital, Dublin, &c.

A HANDBOOK OF DISEASES OF THE EYE AND THEIR TREATMENT. Ninth Edition, Illustrated with Wood Engravings, Colour Tests, etc., large post 8vo, 12s. 6d.
[*Just published.*

W. D'ESTE EMERY, M.D., B.SC. LOND.
Clinical Pathologist to King's College Hospital, and Pathologist to the Children's Hospital, Paddington Green; formerly Assistant Bacteriologist to the Laboratories of the Royal Colleges of Physicians and Surgeons, London.

CLINICAL BACTERIOLOGY AND HÆMATOLOGY FOR PRACTITIONERS. Being the Second Edition of "Bacteriological Diagnosis for Practitioners." With 10 Plates (4 coloured) and 47 illustrations, demy 8vo, 7s. 6d. *nett.*
[LEWIS'S PRACTICAL SERIES. *Just published.*

ALFRED H. CARTER, M.D. LOND., F.R.C.P.
Professor of Medicine, University of Birmingham; Senior Physician to the Queen's Hospital, Birmingham, &c.

ELEMENTS OF PRACTICAL MEDICINE. Ninth Edition, revised throughout, crown 8vo, 10s. 6d.
[*Just published.*

2000, x.—06.

A. C. ABBOTT, M.D.
Professor of Hygiene and Bacteriology, and Director of the Laboratory of Hygiene, University of Pennsylvania.

THE PRINCIPLES OF BACTERIOLOGY: A Practical Manual for Students and Physicians. Seventh Edition, with 100 Illustrations, 24 being coloured, post 8vo, 12s. 6d. *nett.*
[*Just published.*

H. ALDERSMITH, M.B. LOND., F.R.C.S.
Medical Officer, Christ's Hospital, West Horsham.

RINGWORM AND ALOPECIA AREATA: Their Pathology, Diagnosis, and Treatment. Fourth Edition, enlarged, with new Illustrations, demy 8vo, 10s. 6d.

H. CHARLTON BASTIAN, M.A., M.D., F.R.S.
Emeritus Professor of the Principles and Practice of Medicine in University College London, etc.

I.

A TREATISE ON APHASIA AND OTHER SPEECH DEFECTS. With Illustrations, med. 8vo, 15s.

II.

PARALYSES: CEREBRAL, BULBAR, AND SPINAL. A Manual of Diagnosis for Students and Practitioners. With numerous Illustrations, 8vo, 12s. 6d.

III.

VARIOUS FORMS OF HYSTERICAL OR FUNCTIONAL PARALYSIS. Demy 8vo, 7s. 6d.

JOHN FAIRBAIRN BINNIE, A.M., C.M. ABERD.
Professor of Surgery, Kansas City Medical College, &c.

MANUAL OF OPERATIVE SURGERY.
Second Edition, fully illustrated, post 8vo, bound leather, gilt edges, 12s. 6d. *nett.*

RUBERT BOYCE, M.B., M.R.C.S., F.R.S.
Professor of Pathology in University College, Liverpool.

A TEXTBOOK OF MORBID HISTOLOGY FOR STUDENTS AND PRACTITIONERS. With 130 coloured figures, royal 8vo, 31s. 6d.

A. BROCA, M.D.
Chirurgien des Hôpitaux de Paris, &c.
AND
F. LUBET-BARBON, M.D.
Ancien Interne des Hôpitaux des Paris.

MASTOID ABSCESSES AND THEIR TREATMENT. Translated and edited by HENRY J. CURTIS, B.S. and M.D. (Lond.), F.R.C.S. (Eng.), Assistant to the Professor of Pathology, University College, London, &c. With coloured Illustrations, cr. 8vo, 6s.

G. H. BURNHAM, M.D. TOR., F.R.C.S. EDIN., M.R.C.S. ENG.

Professor of Ophthalmology and Otology at the University of Toronto, &c.

THE COMBINED TREATMENT IN DISEASES OF THE EYE. Crown 8vo, 3s. [*Just published.*

JAMES CALVERT, B.A., B.SC., M.D. LOND.

Fellow of the Royal College of Physicians; Lecturer on Materia Medica, Pharmacology, and Therapeutics, to St. Bartholomew's Hospital.

PRACTICAL PHARMACY AND PRESCRIBING FOR STUDENTS OF MEDICINE; being the Course in Use at St. Bartholomew's Hospital. Second Edition, crown 8vo, interleaved, 4s. 6d.

HARRY CAMPBELL, M.D., B.S. LOND., F.R.C.P.

Physician to the North-West London Hospital.

I.

THE CAUSATION OF DISEASE. An exposition of the ultimate factors which induce it. Demy 8vo, 12s. 6d.

II.

FLUSHING AND MORBID BLUSHING, THEIR PATHOLOGY AND TREATMENT. With plates and wood engravings, royal 8vo, 10s. 6d.

III.

DIFFERENCES IN THE NERVOUS ORGANISATION OF MAN AND WOMAN, PHYSIOLOGICAL AND PATHOLOGICAL. Royal 8vo, 15s.

IV.

HEADACHE AND OTHER MORBID CEPHALIC SENSATIONS. Royal 8vo, 12s. 6d.

FRANCIS HENRY CHAMPNEYS, M.A., M.B. OXON., F.R.C.P.

Physician-Accoucheur and Lecturer on Obstetric Medicine at St. Bartholomew's Hospital, &c.

LECTURES ON PAINFUL MENSTRUATION. Royal 8vo, 7s. 6d.

E. TREACHER COLLINS, F.R.C.S.

Assistant Surgeon to the Royal London Ophthalmic Hospital, Moorfields Hunterian Professor, Royal College of Surgeons, England, 1893-94.

RESEARCHES INTO THE ANATOMY AND PATHOLOGY OF THE EYE. With 10 Plates and 82 Figures in the text, demy 8vo, 6s.

WALTER S. COLMAN, M.D., F.R.C.P.

Assistant Physician to the National Hospital for the Paralysed and Epileptic, &c.

SECTION CUTTING AND STAINING: A Practical Introduction to Histological Methods for Students and Practitioners. Second Edition, with Illustrations, crown 8vo, 3s. 6d.

W. H. CORFIELD, M.A., M.D. OXON., F.R.C.P. LOND.

Late Professor of Hygiene and Public Health in University College, London.

I.

THE ETIOLOGY OF TYPHOID FEVER AND ITS PREVENTION, being the Milroy Lectures delivered at the Royal College of Physicians in 1902. Demy 8vo, 2s. 6d.

II.

DWELLING HOUSES: their Sanitary Construction and Arrangements. Fourth Edition, with Illustrations, crown 8vo. 3s. 6d.

III.

DISEASE AND DEFECTIVE HOUSE SANITATION. With Illustrations, crown 8vo, 2s.

SIDNEY COUPLAND, M.D., F.R.C.P.

Physician to the Middlesex Hospital, and Lecturer on Practical Medicine in the Medical School, etc.

NOTES ON THE CLINICAL EXAMINATION OF THE BLOOD AND EXCRETA. Third Edition, 12mo, 1s. 6d.

H. RADCLIFFE-CROCKER, M.D. LOND., B.S., F.R.C.P.

Physician for Diseases of the Skin in University College Hospital.

DISEASES OF THE SKIN: THEIR DESCRIPTION, PATHOLOGY, DIAGNOSIS, AND TREATMENT. Third Edition, with 76 Plates and 112 Illustrations, 2 vols., large 8vo, 30s. net.

J. SADLER CURGENVEN, M.R.C.S., L.R.C.P.

THE CHILD'S DIET. Crown 8vo, 1s. 6d. net.

ROBERT W. DOYNE, F.R.C.S.

Surgeon to the Oxford Eye Hospital; Ophthalmic Surgeon to St. John's Hospital, Cowley, etc.

NOTES ON THE MORE COMMON DISEASES OF THE EYE. With test types, crown 8vo, 2s.

DR. A. DÜHRSSEN.

Professor of Gynæcology, University of Berlin.

I.

A MANUAL OF GYNÆCOLOGICAL PRACTICE FOR STUDENTS AND PRACTITIONERS. Second Edition, translated and edited from the sixth German edition, by JOHN W. TAYLOR, F.R.C.S., Professor of Gynæcology, Mason College, Birmingham; and FREDERICK EDGE, M.D. LOND., F.R.C.S., Surgeon to the Women's Hospital, Wolverhampton. With 125 Illustrations, cr. 8vo, 3s. 6d. net.

II.

A MANUAL OF OBSTETRIC PRACTICE FOR STUDENTS AND PRACTITIONERS. Translated and edited from the sixth German edition by JOHN W. TAYLOR and FREDERICK EDGE. With Illustrations, cr. 8vo, 3s. 6d. net.

EDWARD J. EDWARDES, M.D. LOND.

Member of the Royal College of Physicians, London.

A CONCISE HISTORY OF SMALL-POX AND VACCINATION IN EUROPE. Crown 8vo, 2s. 6d. nett.

MARTIN ELLIOTT, BARRISTER-AT-LAW.

AND

GILBERT ELLIOTT, M.R.C.S., L.R.C.P., D.P.H., D.T.M.

THE PUBLIC HEALTH ACTS AND OTHER SANITARY LAWS AND REGULATIONS; specially prepared for the Diploma of Public Health. Cr. 8vo, 5s. *nett.* [*Just published.*

W. SOLTAU FENWICK, M.D., B.S. LOND., M.R.C.P.

Physician to Out-patients at the Evelina Hospital for Sick Children, &c.

I.

THE DYSPEPSIA OF PHTHISIS: Its Varieties and Treatment, including a Description of Certain Forms of Dyspepsia associated with the Tubercular Diathesis. Demy 8vo, 6s.

II.

DISORDERS OF DIGESTION IN INFANCY AND CHILDHOOD. With illustrations, demy 8vo, 10s. 6d.

J. MILNER FOTHERGILL, M.D.

I.

INDIGESTION AND BILIOUSNESS. Second Edition, post 8vo, 7s. 6d.

II.

GOUT IN ITS PROTEAN ASPECTS. Post 8vo, 7s. 6d.

III.

THE TOWN DWELLER: HIS NEEDS AND HIS WANTS. Post 8vo, 3s. 6d.

SIR DOUGLAS GALTON, K.C.B., HON. D.C.L., LL.D., F.R.S.

Formerly Secretary Railway Department Board of Trade; Assistant Inspector-General of Fortifications, &c.

HEALTHY HOSPITALS. OBSERVATIONS ON SOME POINTS CONNECTED WITH HOSPITAL CONSTRUCTION. With Illustrations, 8vo, 10s. 6d.

E. W. GOODALL, M.D. LOND.

Medical Superintendent of the Eastern Hospital of the Metropolitan Asylums Board; Formerly Medical Registrar to Guy's Hospital;

AND

J. W. WASHBOURN, C.M.G., M.D. LOND., F.R.C.P.

Physician to the London Fever Hospital; Assistant Physician to Guy's Hospital, and Lecturer in the Medical School.

A MANUAL OF INFECTIOUS DISEASES. Illustrated with Plates, Diagrams, and Charts, 8vo, 15s.

JAMES F. GOODHART, M.D. ABERD., F.R.C.P.

Physician to Guy's Hospital, and Consulting Physician to the Evelina Hospital for Sick Children.

ON COMMON NEUROSES; OR THE NEUROTIC ELEMENT IN DISEASE AND ITS RATIONAL TREATMENT. Second Edition, crown 8vo, 3s. 6d.

GEORGE M. GOULD, A.M., M.D.

I.

THE STUDENT'S MEDICAL DICTIONARY: Including all the words and phrases generally used in Medicine, with their proper pronunciation and definitions. Eleventh Edition, with numerous Illustrations, 8vo, 14s. *nett.*

II.

A POCKET MEDICAL DICTIONARY, giving the Pronunciation and Definition of the Principal Words used in Medicine and the Collateral Sciences. Fourth edition, containing 30,000 words. Dose List revised in accordance with the U.S.A. Pharmacopœia, 1905. 32mo, 5s. net.

DR. JOSEF GRUBER.

Professor of Otology in the University of Vienna, &c.

A TEXT-BOOK OF THE DISEASES OF THE EAR. Translated from the German, and Edited by EDWARD LAW, M.D., C.M. EDIN., M.R.C.S. ENG., Surgeon to the London Throat Hospital for Diseases of the Throat, Nose and Ear; and COLEMAN JEWELL, M.B. LOND., M.R.C.S. ENG. Second edition, with 165 Illustrations, and 70 coloured figures, royal 8vo, 28s.

DRS. HARVEY AND DAVIDSON.

SYLLABUS OF MATERIA MEDICA. Revised in accordance with the "British Pharmacopœia" 1898, by WILLIAM MARTINDALE, F.L.S., F.C.S. Tenth edition, fcap. 16mo, 1s. *nett.*

W. S. HEDLEY, M.D.

Medical Officer in charge of the Electro-Therapeutic Department of the London Hospital.

I.

THE HYDRO-ELECTRIC METHODS IN MEDICINE. Second Edition, with Illustrations, demy 8vo, 4s. 6d.

II.

CURRENT FROM THE MAIN: The Medical Employment of Electric Lighting Currents. With Illustrations, demy 8vo, 2s. 6d.

III.

PRACTICAL MUSCLE-TESTING; AND THE TREATMENT OF MUSCULAR ATROPHIES. With Illustrations, demy 8vo, 3s. 6d.

BERKELEY HILL, M.B. LOND., F.R.C.S.
Professor of Clinical Surgery in University College,
AND
ARTHUR COOPER, L.R.C.P., M.R.C.S.
Surgeon to the Westminster General Dispensary, &c.

SYPHILIS AND LOCAL CONTAGIOUS DISORDERS. Second Edition, entirely re-written, royal 8vo, 18s.

L. VERNON JONES, M.D.

GONORRHŒAL ARTHRITIS: its Pathology, Symptoms, and Treatment. With Illustrations, crown 8vo, 2s. 6d.

F. CHARLES LARKIN, F.R.C.S. ENG.
Surgeon to the Stanley Hospital,
AND
RANDLE LEIGH, M.B., B.SC. LOND.
Senior Demonstrator of Physiology in University College, Liverpool.

OUTLINES OF PRACTICAL PHYSIOLOGICAL CHEMISTRY. Second Edition, with Illustrations, crown 8vo, 2s. 6d. *nett.*

J. WICKHAM LEGG, F.R.C.P.
Formerly Assistant Physician to Saint Bartholomew's Hospital.

A GUIDE TO THE EXAMINATION OF THE URINE. Seventh Edition, edited and revised by H. LEWIS JONES, M.D., Medical Officer in charge of the Electrical Department in St. Bartholomew's Hospital. With Illustrations, fcap. 8vo, 3s. 6d.

ARTHUR H. N. LEWERS, M.D. LOND., F.R.C.P. LOND.
Senior Obstetric Physician to the London Hospital; late Examiner in Obstetric Medicine to the University of London.

CANCER OF THE UTERUS: A Clinical Monograph on its Diagnosis and Treatment. With 3 coloured Plates and numerous Illustrations, 8vo, 10s. 6d. *nett.*

WILLIAM A. M'KEOWN, M.D., M.CH.
Surgeon to the Ulster Eye, Ear and Throat Hospital, Belfast; Lecturer on Ophthalmology and Otology, Queen's College, Belfast.

A TREATISE ON "UNRIPE" CATARACT, and its Successful Treatment by Operation. With Illustrations, roy. 8vo, 12s. 6d. *nett.*

LEWIS'S PRACTICAL SERIES.

In Demy and Crown 8vo Volumes, with Illustrations.

CLINICAL BACTERIOLOGY AND HÆMATOLOGY FOR PRACTITIONERS. By W. D'ESTE EMERY, M.D., B.Sc. LOND., Clinical Pathologist to King's College Hospital, &c. 7s. 6d. *net.*
[*Just published.*

DISEASES OF THE NERVOUS SYSTEM. A Handbook for Students and Practitioners. By C. E. BEEVOR, M.D. Lond., F.R.C.P., Physician to the National Hospital for the Paralysed and Epileptic. 10s. 6d.

THE TREATMENT OF PULMONARY CONSUMPTION. By VINCENT D. HARRIS, M.D. Lond., F.R.C.P., and E. CLIFFORD BEALE, M.A., M.B., Cantab., F.R.C.P., Physicians to the City of London Hospital for Diseases of the Chest, &c. 10s. 6d.

THE SURGICAL DISEASES OF CHILDREN AND THEIR TREATMENT BY MODERN METHODS. By D'ARCY POWER, F.R.C.S., Surgeon to St. Bartholomew's Hospital. 10s. 6d.

DISEASES OF THE NOSE AND THROAT. By F. de HAVILLAND HALL, M.D., F.R.C.P. Lond., Physician to the Westminster Hospital, and HERBERT TILLEY, M.D., B.S. Lond., F.R.C.S. Eng., Surgeon to the Hospital for Diseases of the Throat, Golden Square. Second Edition, 10s. 6d.

PUBLIC HEALTH LABORATORY WORK. By H. R. KENWOOD, M.B., D.P.H., F.C.S., Professor of Hygiene and Public Health, University College, &c. Third Edition, 10s. 6d.

MEDICAL MICROSCOPY. By FRANK J. WETHERED, M.D., M.R.C.P., Medical Registrar to the Middlesex Hospital. 9s.

MEDICAL ELECTRICITY. By H. LEWIS JONES, M.A., M.D., F.R.C.P., Medical Officer, Electrical Department, St. Bartholomew's Hospital. Fifth Edition, thoroughly revised, demy 8vo, 12s. 6d. *net.*
[*Just published.*

HYGIENE AND PUBLIC HEALTH. By LOUIS PARKES, M.D., D.P.H. Lond. Univ., Lecturer on Public Health at St. George's Hospital, and H. R. KENWOOD, M.B., D.P.H., F.C.S., Professor of Hygiene and Public Health at University College, London. Second Edition, 12s.

MANUAL OF OPHTHALMIC PRACTICE, By C. HIGGENS, F.R.C.S., Lecturer on Ophthalmology at Guy's Hospital Medical School, &c. Second Edition, 7s. 6d.

A PRACTICAL TEXTBOOK OF THE DISEASES OF WOMEN. By ARTHUR H. N. LEWERS, M.D. Lond., F.R.C.P. Lond., Senior Obstetric Physician to the London Hospital. Sixth Edition, 10s. 6d.

ANÆSTHETICS: their Uses and Administration. By DUDLEY W. BUXTON, M.D., B.S., M.R.C.P., Administrator of Anæsthetics at University College Hospital, &c. Fourth Edition.
[*Just ready.*

ON FEVERS: their History, Etiology, Diagnosis, Prog-nosis and Treatment. By A. COLLIE, M.D. 8s. 6d.

HANDBOOK OF DISEASES OF THE EAR. By URBAN PRITCHARD, M.D. (Edin.), F.R.C.S., Professor of Aural Surgery at King's College, London, &c. Fourth Edition. [*In preparation.*

A PRACTICAL TREATISE ON DISEASES OF THE KID-NEYS AND URINARY DERANGEMENTS. By C. H. RALFE, M.A. M.D. Cantab., F.R.C.P., Physician to the London Hospital. 10s. 6d.

DENTAL SURGERY FOR MEDICAL PRACTITIONERS AND STUDENTS OF MEDICINE. By ASHLEY W. BARRETT M.B. Lond., M.R.C.S., L.D.S., Consulting Dental Surgeon to the London Hospital. Fourth Edition, 3s. 6d.

BODILY DEFORMITIES AND THEIR TREATMENT. By H. A. REEVES, F.R.C.S. Ed., Senior Assistant Surgeon and Teacher of Practical Surgery at the London Hospital. 8s. 6d.

J. M. H. MACLEOD, M.A., M.D., M.R.C.P.

Assistant Physician for Diseases of the Skin, Charing Cross Hospital; Physician to the Skin Department, Victoria Hospital for Children; Lecturer on Skin Diseases, London School of Tropical Medicine.

PRACTICAL HANDBOOK OF THE PATHOLOGY OF THE SKIN. An Introduction to the Histology, Pathology, and Bacteriology of the Skin, with Special Reference to Technique. With 8 Coloured and 32 black and white Plates, demy 8vo, 15s. *nett.*

W. HARRISON MARTINDALE, PH.D., F.C.S.

A SYNOPSIS OF THE PRINCIPAL CHANGES IN THE UNITED STATES PHARMACOPŒIA, effected by the eighth decennial revision, 1900, compared with that of 1890, and with the British Pharmacopœia, 1898, post 8vo, 2s. *nett.*

WILLIAM MARTINDALE, F.L.S., F.C.S.

Late President and Examiner of the Pharmaceutical Society,

AND

W. WYNN WESTCOTT, M.B. LOND., D.P.H.

H.M.'s Coroner for North-East London.

THE EXTRA PHARMACOPŒIA.

Revised by W. H. MARTINDALE, PH.D., F.C.S., and W. WYNN WESTCOTT, M.B. LOND. &c. Twelfth Edition, limp roan, med. 24mo, 10s. *nett.* [*Just published.*

A. STANFORD MORTON, M.B., F.R.C.S. ENG.

Surgeon to the Moorfields Ophthalmic Hospital; Ophthalmic Surgeon to the Great Northern Central Hospital, &c.

REFRACTION OF THE EYE; its Diagnosis and the Correction of its Errors. Seventh Edition, thoroughly revised, small 8vo, 3s. 6d. [*Just published.*

C. W. MANSELL MOULLIN, M.A., M.D. OXON., F.R.C.S. ENG.

Surgeon and Lecturer on Physiology at the London Hospital, &c.

I.

INFLAMMATION OF THE BLADDER AND URINARY FEVER. 8vo, 5s.

II.

ENLARGEMENT OF THE PROSTATE: its Treatment and Radical Cure. Third Edition, 8vo, 6s.

III.

SPRAINS; THEIR CONSEQUENCES AND TREATMENT. Second Edition, crown 8vo, 4s. 6d.

WILLIAM MURRAY, M.D., F.R.C.P. LOND.

I.

ROUGH NOTES ON REMEDIES. Fifth Edition, enlarged, crown 8vo, 4s. *nett.* [*Just ready.*

II.

ILLUSTRATIONS OF THE INDUCTIVE METHOD IN MEDICINE. Crown 8vo, 3s. 6d.

GEORGE R. MURRAY, M.A., M.D. CAMB., F.R.C.P.

Heath Professor of Comparative Pathology in the University of Durham; Physician to the Royal Infirmary, Newcastle.

DISEASES OF THE THYROID GLAND. Part I., MYXŒDEMA AND CRETINISM. With numerous Illustrations, demy 8vo, 7s. 6d.

WILLIAM MURRELL, M.D., F.R.C.P.

Physician to Westminster Hospital.

WHAT TO DO IN CASES OF POISONING. Ninth Edition, royal 32mo, 3s. 6d.

G. OLIVER, M.D., F.R.C.P.

I.

STUDIES IN BLOOD PRESSURE, PHYSIOLOGICAL AND CLINICAL. Fcap. 8vo, 2s. 6d. *nett.*

II.

A CONTRIBUTION TO THE STUDY OF THE BLOOD AND BLOOD-PRESSURE. Founded on portions of the Croonian Lectures delivered before the Royal College of Physicians, London, 1896, with considerable extensions. With Illustrations, demy 8vo, 7s. 6d.

DR. A. ONODI.

Lecturer on Rhino-Laryngology in the University of Budapest.

THE ANATOMY OF THE NASAL CAVITY, AND ITS ACCESSORY SINUSES. An Atlas for Practitioners and Students, translated by ST. CLAIR THOMSON, M.D. LOND. F.R.C.S. ENG., M.R.C.P. LOND. Plates, small 4to, 6s. *nett.*

WILLIAM OSLER, M.D., F.R.C.P. LOND.

Professor of Medicine, University of Oxford.

ÆQUANIMITAS: With other Essays and Addresses to Medical Students, Nurses and Practitioners of Medicine. New Edition, with Three new Addresses. Post 8vo, [*Just ready.*

KURRE W. OSTROM.

Instructor in Massage and Swedish Movements in the Philadelphia Polyclinic and College for Graduates in Medicine.

MASSAGE AND THE ORIGINAL SWEDISH MOVEMENTS; their application to various diseases of the body. Sixth Edition, with 115 illustrations, crown 8vo, 3s. 6d. *nett.* [*Just published.*

LOUIS PARKES, M.D. LOND., D.P.H.

Lecturer on Public Health at St. George's Hospital, &c.

INFECTIOUS DISEASES, NOTIFICATION AND PREVENTION. Fcap. 8vo, cloth, 2s. 6d., roan, 4s. 6d.

SIR RICHARD DOUGLAS POWELL, BART., M.D. LOND., F.R.C.P.

Physician Extra-ordinary to H.M. the King; Physician to the Middlesex Hospital, &c.

I.

THE LUMLEIAN LECTURES ON THE PRINCIPLES WHICH GOVERN TREATMENT IN DISEASES AND DISORDERS OF THE HEART. Coloured Diagrams, demy 8vo, 6s.

II.

DISEASES OF THE LUNGS AND PLEURÆ INCLUDING CONSUMPTION. Fourth Edition, with coloured plates and wood-engravings, 8vo, 18s.

DR. THEODOR PUSCHMANN.

Public Professor in Ordinary at the University of Vienna.

HISTORY OF MEDICAL EDUCATION FROM THE MOST REMOTE TO THE MOST RECENT TIMES. Translated by EVAN H. HARE, M.A. (OXON.), F.R.C.S. (ENG.), F.S.A. Demy 8vo, 21s.

LOUIS BATHE RAWLING, M.B., B.C. (CANT.), F.R.C.S. (ENG.).

Assistant Surgeon, Senior Demonstrator of Anatomy, and Demonstrator of Practical Surgery, St. Bartholomew's Hospital; Assistant Surgeon to the German Hospital, Dalston; late Hunterian Professor, Royal College of Surgeons, England.

LANDMARKS AND SURFACE MARKINGS OF THE HUMAN BODY. Second Edition, demy 8vo, 25 plates (3 in colour), 5s. *nett.*

SAMUEL RIDEAL, D.SC. (LOND.), F.I.C., F.C.S.

Fellow of University College, London.

I.

PRACTICAL ORGANIC CHEMISTRY. The detection and properties of some of the more important Organic Compounds. Second Edition, 12mo, 2s. 6d.

II.

PRACTICAL CHEMISTRY FOR MEDICAL STUDENTS, Required at the First Examination of the Conjoint Examining Board in England. Fcap. 8vo, 2s.

J. JAMES RIDGE, M.D., B.S., B.A., B.SC. LOND.

Medical Officer of Health, Enfield.

ALCOHOL AND PUBLIC HEALTH. Second Edition, crown 8vo, 2s.

WILLIAM ROSE, B.S., M.B. LOND., F.R.C.S.

Professor of Surgery in King's College, London, and Surgeon to King's College Hospital, &c.

ON HARELIP AND CLEFT PALATE. Demy 8vo, with Illustrations, 6s.

BERNARD ROTH, F.R.C.S.

Orthopædic Surgeon to the Royal Alexandra Hospital for Sick Children, &c.

THE TREATMENT OF LATERAL CURVATURE OF THE SPINE. Second Edition, with Photographic and other Illustrations, roy. 8vo, 10s. 6d.

W. G. SAVAGE, M.D., B.SC., D.P.H.

Medical Officer of Health and Public Analyst, Colchester; late Lecturer on Bacteriology and Public Health, University College, Cardiff, &c.

THE BACTERIOLOGICAL EXAMINATION OF WATER SUPPLIES. With tables and illustrations, post 8vo, [*Just ready.*

G. E. SHUTTLEWORTH, B.A., M.D.

Recently Medical Examiner of Defective Children, School Board for London; late Medical Superintendent, Royal Albert Asylum for Idiots and Imbeciles of the Northern Counties, Lancaster, &c.

MENTALLY-DEFICIENT CHILDREN: their Treatment and Training. Second Edition, with Illustrations, crown 8vo, 5s. *nett.*

E. HUGH SNELL, M.D., B.SC., LOND.

Diplomate in Public Health of the University of Cambridge; Medical Officer of Health, Coventry; late London County Council Medical Officer to the Blackwall Tunnel.

COMPRESSED AIR ILLNESS, OR SO-CALLED CAISSON DISEASE. Demy 8vo, 10s. 6d.

LOUIS STARR, M.D.

Physician to the Children's Hospital, Philadelphia, &c.

HYGIENE OF THE NURSERY. Including the General Regimen and Feeding of Infants and Children; Massage, and the Domestic Managemenr of the Ordinary Emergencies of Early Life. Seventh Edition, with Illustrations, cr. 8vo, 3s. 6d.
[*Just published.*

C. W. SUCKLING, M.D. LOND., M.R.C.P.

Professor of Materia Medica and Therapeutics at the Queen's College, Physician to the Queen's Hospital, Birmingham, etc.

I.

MOVABLE KIDNEY: A CAUSE OF INSANITY, Headache, Neurasthenia, Insomnia, Mental Failure, and other Disorders of the Nervous System. A cause also of Dilatation of the Stomach. With Illustrations in Half-tone, &c., demy 8vo, cloth, 5s. *nett.*

ON THE DIAGNOSIS OF DISEASES OF THE BRAIN, SPINAL CORD, AND NERVES. With Illustrations, crown 8vo, [*New edition in preparation.*

III.

ON THE TREATMENT OF DISEASES OF THE NERVOUS SYSTEM. Crown 8vo, 7s.6d.

J. BLAND-SUTTON, F.R.C.S.

Assistant Surgeon to the Middlesex Hospital.

LIGAMENTS: THEIR NATURE AND MORPHOLOGY. Third Edition, wood engravings, post 8vo, 4s. 6d.

ALBERT TAYLOR.

Member Royal Sanitary Institute; Sanitary Inspector, City of Westminster; late Chief Sanitary Inspector to the Vestry of St. George, Hanover Square, tc.

THE SANITARY INSPECTOR'S HANDBOOK. Fourth Edition, with Illustrations, cr. 8vo, 6s.

HERBERT TILLEY, M.D., B.S. LOND., F.R.C.S. ENG.
Surgeon to the Throat Hospital, Golden Square; Lecturer on Diseases of the Nose and Throat, London Post-Graduate College and Polyclinic.

PURULENT NASAL DISCHARGES: their Diagnosis and Treatment. Second Edition, enlarged, with six Plates and numerous Illustrations, crown 8vo, 4s. *nett.*

E. W. AINLEY WALKER, M.A., D.M. OXON.,
Fellow and Praelector of University College, Oxford; late Gordon Lecturer in Experimental Pathology at Guy's Hospital, &c.

THE GENERAL PATHOLOGY OF INFLAMMATION, INFECTION, AND FEVER. Being the Gordon Lectures for 1902, crown 8vo, 4s. 6d. net.

HUGH WALSHAM, M.A., M.D. CANTAB.
Fellow of the Royal College of Physicians; Chief Assistant in the Electrical Department of St. Bartholomew's Hospital; Senior Assistant Physician to the City of London Hospital for Diseases of the Chest.
AND
GEORGE HARRISON ORTON, M.A., M.D. CANTAB.
Assistant in the Röntgen Ray Department of St. Bartholomew's Hospital; Medical Officer in charge of the X-Ray Department of the National Hospital for Diseases of the Heart, and the Cheyne Hospital for Sick Children.

THE X-RAYS IN THE DIAGNOSIS OF DISEASES OF THE CHEST. With 18 specially prepared plates from selected negatives, and other illustrations, demy 8vo, 6s. net.
[*Just published.*

R. PROSSER WHITE, M.D. EDIN., M.R.C.S. ENG.
Life Vice-President and Honorary Medical Officer, Royal Albert Edward Infirmary, Wigan.

CATARRHAL FEVERS, COMMONLY CALLED COLDS: their Causes, Consequences, Control, and Cure. With 3 plates, extra demy 8vo, 4s. [*Now ready.*

E. T. WILSON, M.B. OXON., F.R.C.P. LOND.
Physician to the Cheltenham General Hospital, &c.

DISINFECTANTS AND ANTISEPTICS: HOW TO USE THEM. In Packets of one doz. price 1s., by post 1s. 1d. [*Thoroughly revised.*

BERTRAM C. A. WINDLE, D.SC., M.D., M.A. DUBL.
President, Queen's College, Cork; Examiner in Anatomy, Royal College of Physicians, London, &c.

A HANDBOOK OF SURFACE ANATOMY AND LANDMARKS. Third Edition, with Illustrations, post 8vo, 4s. *nett.*

EDWARD WOAKES, M.D. LOND.
Senior Aural Surgeon, London Hospital; Lecturer on Diseases of the Ear, London Hospital Medical College.

ON DEAFNESS, GIDDINESS, AND NOISES IN THE HEAD. Fourth Edition, Part I., with Illustrations, 8vo, 10s. 6d.

All Charts sent post free. Specimen of any Chart free.

LEWIS'S DIET CHARTS. A Suggestive set of Diet Tables for the use of Physicians, for handing to Patients after Consultation, modified to suit Individual Requirements; for Albuminuria, Anæmia and Debility, Constipation, Diabetes, Diarrhœa, Dyspepsia, Eczema, Fevers, Gall Stones, Gout and Gravel, Heart Disease (chronic), Nervous Diseases, Obesity, Phthisis, Rheumatism (chronic); and Blank Chart for other diseases. 5s. per packet of 100 charts, post free.

A special leaflet on the Diet and Management of Infants is sold separately. 12, 1s.; 100, 7s. 6d., post free.

CHART FOR RECORDING THE EXAMINATION OF URINE. Designed for the use of medical men, analysts and others making examinations of the urine of patients. 10, 1s.; 100, 7s. 6d.; 250, 15s.; 500, 25s.; 1000, 40s.

CLINICAL CHARTS FOR TEMPERATURE OBSERVATIONS, ETC. Arranged by W. RIGDEN, M.R.C.S. 12, 1s.; 100, 7s.; 250, 15s.; 500, 28s.; 1000, 50s.

LEWIS'S HÆMATOLOGICAL CHART. A new Chart designed for recording Counts, &c., designed by Dr. E. R. TURTON. 1000, 50s.; 500, 28s.; 250, 15s.; 100, 7s.; 12, 1s.

LEWIS'S CLINICAL CHART, SPECIALLY DESIGNED FOR USE WITH THE VISITING LIST. Arranged for four weeks, and measures 6 × 3 inches. 12, 6d.; 25, 1s.; 100, 2s. 6d.; 500, 11s. 6d.; 1000, 20s.

LEWIS'S "HANDY" TEMPERATURE CHART. Arranged for three weeks, with space for notes of case as to diet, &c., and ruled on back for recording observations on urine. 20, 1s.; 50, 2s.; 100, 3s. 6d.; 500, 14s.; 1000, 25s.

Uniform in size and price with the "Handy" Chart.

LEWIS'S FOUR-HOUR TEMPERATURE CHART. Meets the requirements of a chart on which the temperature and other observations can be recorded at intervals of four hours. Each chart will last a week.

LEWIS'S NURSING CHART. Printed on both sides.

LEWIS'S BLOOD-PRESSURE AND PULSE CHART. An entirely new Chart.

*** MR. LEWIS is in constant communication with the leading publishing firms in America and has transactions with them for the sale of his publications in that country. Advantageous arrangements are made in the interests of Authors for the publishing of their works in the United States.

MR. LEWIS'S publications can be procured of any Bookseller in any part of the world.

Complete Catalogue of Publications post free on application.

Printed by H. K. Lewis, Gower Street, London, W.C.